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Management of the ventriculoperitoneal shunt infections

Diagnóstico e conduta nas infecções em sistemas de derivação ventriculoperitoneais

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Abstract

Ventriculoperitoneal shunt (VPS) insertion account for a large number of neurosurgical procedure. Although this device results in great improvement in neurological function and survival of patients with hydrocephalus, VPS are associated with complications, especially infections and malfunction. These infections are a common cause of malfunctioning of the shunt, associated with an increased risk of seizures, cognitive changes and increasing the mortality, with a mortality rate ranging between 30% and 40%. The incidence of post-operative infections in catheters varies greatly according to the statistics of each neurosurgical center, reported rates of 0 to 34%, with an average around 10%. Many surgical aspects have been reported as risk factors for infections of VPS, as etiology of hydrocephalus, age of the patient, prior malfunction, duration of surgery, surgeon expertise and cerebrospinal fistula. The high social and financial cost of infections of VPS leads us to seek effective measures of prevention. In this article the authors perform a critical review of the literature about management in ventriculoperitoneal shunt infection.

Key words: Hydrocephalus, ventriculoperitoneal shunt, ventriculitis, infection.

Resumo

Derivação ventriculoperitoneal representa o procedimento mais comum em unidades de neurocirurgia. Embora este dispositivo resulte em grande melhora neurológica e sobrevida dos pacientes com hidrocefalia, as derivações são associadas a complicações, especialmente infeções e mau funcionamento. Estas infecções são uma causa comum de disfunção da derivação, associadas com um risco aumentado de convulsões, alterações cognitivas, com uma taxa de mortalidade variando entre 30% e 40%. A incidência de infecções pós-operatórias em cateteres varia muito de acordo com as estatísticas de cada centro neurocirúrgico, com taxas relatadas de 0 a 34%, com uma média de cerca de 10%. Muitos aspectos cirúrgicos têm sido relatados como fatores

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de risco para infecções da VPS, como etiologia da hidrocefalia, idade do paciente, duração da cirurgia, perícia da equipe e presença de fístula líquórica. O elevado custo social e financeiro destas infecções nos leva a buscar medidas eficazes de prevenção. Neste artigo, os autores realizam uma revisão crítica da literatura sobre diagnóstico e conduta na infecção em sistemas de derivação ventriculoperitoneal.

**Palavras-chave:** Hidrocefalia, derivação ventriculoperitoneal, ventriculite, infecção.

**Introduction**

Ventriculoperitoneal shunts (VPS) insertion account for a large number of procedures in neurosurgical practice. Although this device results in great improvement in neurological function and survival of patients with hydrocephalus, VPS are associated with numerous complications, including infections of the catheter. Shunts have significantly changed the overall outcome figures over the past three decades. Thanks to the progress made, the prognosis of patients with hydrocephalus today depends more on the prognosis of the causative lesion than on the hydrocephalus itself. However, infection is still a serious problem in VPS, with a mortality rate ranging between 30% and 40%, in patients who survive are at high risk of developing or neurological worsening, cognitive and intellectual deficits.

According to the national survey on cerebrospinal fluid shunting in the United States, approximately 69,000 patients are discharged each year with the diagnosis of hydrocephalus, and approximately 33,000 shunts are placed each year. Unfortunately, 48% of all procedures considered in the study were shunt revisions, and about US$ 48,000,000 was devoted to revision. The incidence of post-operative infections in catheters varies greatly according to the statistics of each neurosurgical center, reported rates of 0 to 34%. With an average around 10%. Many surgical aspects have been reported as risk factors for infections of VPS, as etiology of hydrocephalus, age of the patient, prior malfunction, duration of surgery, surgeon expertise, surgeon expertise, and cerebrospinal fistula. About 90% of VPS infections are diagnosed in the first 6 months after surgery, and the majority in the first 3 months, which reinforces the basic premise that these infections are a complication of surgery.

The rates of catheter infection in the pediatric population are higher among children younger than 1 years. Although the causes for this are not clearly established fact, children between 1 and 6 months of age have a greater susceptibility to those infections due to a deficiency in his immune system on against bacteria. Another etiology are changes that occur in the skin and its bacterial flora throughout childhood, and the density of aerobic coconuts on the skin is greater in younger children.

Kestle et al. describe rates of recurrence of infections from catheter approximately 30%, that about two thirds are caused by the same agent. The main risk factor for recurrence is reported as a history of infection from catheter in the last six months preceding the placement of VPS.

**Clinical and diagnosis**

George et al. describe the VPS infections related to surgery those that occur up to 6 months after surgery. Must be investigated patients with signs of meningitis, fever, inflammation in the path of the catheter, malfunction of the system, or secretion in the wound dehiscence, symptoms such as abdominal pain, distension or the presence of intra-abdominal cyst. Other symptoms that may be related to infection are seizures, irritability and changes in the level of consciousness. Often nonspecific symptoms hinder early diagnosis, where there are the signs and symptoms described above, should be made a study of neuroimaging and collection of cerebrospinal fluid (CSF) for analysis.

Radiological images can reveal ventricular dilatation on CT in skull or disconnections throughout the system, highlighted by radiographs of the path of the catheter. Patients with suspected malfunction distal, or abdominal pain should be submitted to ultrasound or CT, abdomen, to discard collections abdominal.

Examination of CSF should be performed in all patients with suspected shunt infection. Bacterial and fungal cultures of CSF, in addition to blood culture, should be obtained from these patients. Administration of antibiotics to a patient with suspected shunt infection before obtaining CSF culture reduces the likelihood of obtaining a positive culture. A CSF collect through puncture the system should be done with fine needle in a technique completely sterile and should be done anti-sepsis and aseptic skin with iodine or chlorinated solution. Already in puncture you can see the malfunction of the cranial catheter if there is no flow of CSF. In the CSF analysis think it is in infection when there is a low level of glucose, high protein and high cellularity with predomi-
nance of neutrophils. The cultures were positive in approximately 50% of cases. \(^{(18)}\)

**Pathogens**

For years, *Staphylococcus epidermidis* coagulase-negativos were considered the most common agents involved in VPS infections, followed by *Staphylococcus aureus*. Despite these still are the most common agents, the indiscriminate use of antibiotics and the increase of neurosurgical procedures are changing the epidemiology of the causative agents of these infections. \(^{(14)}\) *Staphylococcus epidermidis* is responsible for about 52.8 to 88.9% of infections, and *Staphylococcus aureus* for 12 - 40%. Other important microorganisms are gram negative (9-22%), stand out *Enterobacteria, Klebsiella pneumoniae, Pseudomonas aeruginosa*. Infections by anaerobics like *Propionibacterium acne* are reported, as well as fungal infections, but are more rare. \(^{(11)}\) The great prevalence of pathogens of the human skin normal flora reinforces the idea that the main source of infection is contamination of the system during surgery. Other routes of infection, a minor proportion, are the hematogenous and catheter colonization by intra-abdominal agents. \(^{(19)}\)

McGirt et al. describe that no independent clinical characteristics that are associated with specific agents, and therefore the clinical suspicion of infection by specific agent dependent on the experience of the doctor and has low accuracy. \(^{(3)}\)

**Prophylaxis and surgical technique**

The high social and financial cost of infections of VPS leads us to seek effective measures of prevention. But though there are many studies on the VPS infections, with various forms of prevention, remaining work statistically consistent. \(^{(19)}\)

In classical paper about VPS infections, Choux et al. \(^{(2)}\) describe the decline in the rates of infection from catheter per patient, in his unit, 15.56% to 0.33%, after implementation of a protocol for prevention of these infections. This protocol involved actions in all perioperative period. The patients were prepared meticulously, the infections were treated, and they underwent hair shampoo the evening before and the morning of the procedure using polvidine preparation. The VPS surgeries were carried out early in the day prior to other neurosurgical procedures, they were programmed to last from 20 to 40 minutes, and no more than four VPS surgeries were accomplished a day. The number of people in the surgical room was limited to four: an experienced surgeon in shunt implantation, his/her assistant, the anesthesist and the circulating nurse. The appropriate equipment was chosen by the surgeon, in agreement with the etiology of the hydrocephalus and with the patient's age. This sterile device was opened minutes before the implant to avoid larger time of exposition, and immediately immersed in a gentamicine bath. Only two small skin incisions were made without an intermediate incision, beginning for the abdominal. The preassembled shunt was placed in position and the exposed distal catheter was covered by a sterile drape during cannulation of the lateral ventricle and insertion of the proximal catheter. The valve was carefully positioned in the subgaleal space in order to avoid lesions in the skin and damage of the equipment, and the distal catheter was introduced in the peritoneal cavity under direct vision.

Finally, the incision of the skull was sutured in a single layer using interrupted sutures and the abdominal suture was closed in layers in classic manner. In the surgical induction all patients received 100mg/kg of oxacillin. Antibiotics were not administered in the postoperative, and the curatives were changed every 2 days under sterile technique. On average, patients were hospitalized for 4 days for a primary shunt, and hospitalized for 2 days for shunt revision. With this protocol the authors lowered their infection rate for patient from 15,56% to 0,33% and for procedure from 7,75% to 0,17%.

Other papers demonstrate reduction in the infection rate with the use of shunt catheters impregnated with antibiotics, as rifampicin or clindamicin. The prophylaxis with endovenous third generation cephalosporins (ceftriaxone) has also shown effectiveness in this subject. \(^{(19,20)}\)

**Treatment**

The treatment of VPS infections varies between institutions and neurosurgeons; however, despite reports of cure just with antibioticotherapy, \(^{(17)}\) is verified that the take out of the shunt or distal catheter exteriorization, treatment with antibiotics for some weeks and subsequent relocation of the system is shown to be more effective. \(^{(1,20)}\)

As there is a great preponderance of the skin agents in these infections (S. epidermidis and S. aureus), resistance to oxacillin and polimicrobial infection, is recommended to begin the treatment empirically with vancomycin and a third or fourth generation cephalosporin, associated with immediate take out of the shunt or distal catheter exteriorization. Shunt-dependent patients should stay
with external ventricular drain or with exteriorized distal catheter during the clinical treatment (for a mean of 21 days). New VPS should be internalized, usually contralateral to the old system, in a new trepanation, after negative CSF cultures.

All shunts are designed to maintain normal intracranial pressure. More than a dozen different commercial shunts are currently available. The design of the valve is controversial. Essentially, 2 types of shunts are available: the pressure-regulating shunt and the flow-regulating shunt (as well as 2 brands of programmable shunt valves). The pressure-regulating shunts are designed to maintain a difference of pressure between their inlet and outlet and allow flow of CSF once the preset pressure has been reached. The flow-regulating shunts are designed to allow a constant flow of CSF, simulating the normal flow. Despite different designs, large randomized trials have been unable to demonstrate differences between the various types.

In our service, the management of infections associated with CNS shunts was usually surgical removal of the shunt, temporary external CSF drainage, parenteral antimicrobial therapy with shunt replacement after the infection had been eradicated (figure 1). We believe that this technique is the most cost-effective method of treatment for CSF shunt infection. In cases with recurrent infection, the combination of intraventricular gentamicin and vancomycin with systemic antibiotic therapy significantly decreased the incidence of new shunt infection. It is presumed that intraventricular antibiotic therapy extends antibiotic coverage into the CSF. This approach is based on studies of literature about shunt infections treatment, adapted with the experience of our neurosurgical unit. This protocol is being applied in a prospective study in collaboration with the infection control unit of our hospital still in progress.

**Conclusions**

In the last twenty years it is noticed a reduction in infection rate related to VPS in most of the institutions, however this still a serious and important problem in neurosurgery services all over the world, leading to high financial and social cost for patients, family and society as a whole, what turns this subject of high importance in the neurological practice. Despite of a vast literature related, there are still controversial points in the prevention and treatment of these infections without statistically reliable data. However, works accomplished in renowned institutions demonstrate that the use of specific protocols in the pre, intra, and postoperative can lower significantly the infection rate related to VPS. The use of aseptic techniques and the use of endovenous prophylac-

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**Figure 1. Protocol for diagnosis and treatment of the ventriculoperitoneal shunt infection**
tic antibiotics seem to be useful in the prevention of this complication.

The need for prospective studies to identify risk factors, prevention and treatment of shunt infections becomes clear when we observed the lack of consensus in most neurological surgery units around the world. Therefore, an effective protocol created according to each institution features is essential for reduce VPS infection which is known to be a life threatening condition and of great financial costs.

References


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