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Early Application of Ventriculoperitoneal Shunt in Secondary Hydrocephalus

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Abstract

Background: Ventriculoperitoneal Shunt (VPS) is the commonest neurosurgical procedures for the management of hydrocephalus, but there is a lack of consensus on the specific management of intracranial infection with hydrocephalus. Here, we presented two cases of hydrocephalus with intracranial infection and VPS was successfully undergone in the early stage of infection control.

Methods: Two patients with hydrocephalus had varying degrees of intracranial infection before operation, and clinical symptoms of hydrocephalus were worsening. VPS was performed in the early stage when intracranial infection could be controlled, and the patients were evaluated clinically and radiologically after operation.

Result: During the in-hospital observation after operation and the follow-up after discharge, the symptoms of hydrocephalus were significantly improved as well as intracranial infection. None of both patients developed postoperative complications.

Conclusion: For specific patients, VPS, in the early stage of intracranial infection control can be considered as a relatively safe and effective treatment.

Introduction

Hydrocephalus, characterized by the triad of gait disturbance, urinary incontinence, and memory impairment, is the commonest neurosurgical disorder [1]. On an etiological basis, it can be classified as primary and secondary [2,3]. The imbalance in the Cerebrospinal Fluid (CSF) homeostasis is ultimately considered to be culprit [1]. Secondary hydrocephalus is more common, which is primarily caused by trauma, hemorrhage and infection [2]. Due to our limited understanding of the molecular physiology of the disease, the standard management of hydrocephalus is still the Ventricular shunt at present [4].

In a comparative study conducted by Schreffler et al. [5] indicated that the insertion of a shunt, when CSF sterility is achieved, is the most effective treatment method of hydrocephalus with intracranial infection. Another study suggested that when CSF sterility was achieved, it took at least 10 to 14 days of antibiotic treatment before VPS can be performed [6].

At present, there is no consensus on when to perform VPS for hydrocephalus with intracranial infection. Herein, we present two patients of hydrocephalus with intracranial infection who were successfully treated with ventriculoperitoneal shunt. No severe postoperative complications occurred throughout the follow-up period.

Case Series

Case 1

Admission situation: A 43-year-old man was admitted to our hospital for 2 weeks because of recurrent dizziness with nausea and vomiting. Previously suffered from right Chronic Suppurative Otitis Media (CSOM). On examination, stiff-neck is suspected to be positive and there were no other neurological deficiencies, GCS scores were 15 points. Cerebrospinal fluid routine suggested that the white blood cell count was 1035/μL and the percentage of multinucleate cells was 87%. Computed Tomography (CT) scans showed hydrocephalus was distinguished by ventricular dilatation. Considering the serious condition, he was admitted to the intensive care unit for treatment.

Treatment process: After communicating with the patient's family, on the basis of reducing intracranial pressure and anti-infection, the patient received surgical treatment of suppurative otitis media at first. On the sixth day after the operation, the patient developed progressive cognitive

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impairment and decreased level of consciousness. Enhancing Magnetic Resonance Imaging (MRI) of skull base showed general enhancement of dura mater and ventricular wall, while the leptomeningeal enhancement is relatively obvious, which suggested infection. At the same time, it also suggested that hydrocephalus was in progress. Then we performed emergency External Ventricular Drains (EVDs), and the patient's symptoms were significantly relieved. One week after the operation, we reviewed CT, which showed ventricle is smaller than before. No bacteria and fungi were found in cerebrospinal fluid culture for five days. The patient's symptoms such as headache were also better than before. Considering the high risk of intracranial infection caused by long-term extra-ventricular drainage [7-9], VPS was performed on the 8th day after the operation. During hospitalization, systemic intravenous antimicrobials (vancomycin) were used to control intracranial infection. After discharge, Linezolide tablets were used to control infection. After discharge, 5 month follow-up was carried out and there were no obvious complications. The patient indicated that the symptoms had been significantly improved.

Case 2

Condition at the time of admission: Two months ago, the patient underwent VPS in our hospital. One month after operation, he was hospitalized because of fever and convulsions. Seven days ago, the fever occurred again without obvious inducement, and the highest body temperature was 39.6°C, accompanied by chills and lethargy. He went to the local clinic and was treated with antibiotics and antipyretic drugs, and the body temperature decreased. Fever occurs again at night with chills, which can be cooled after antipyretic drugs are given. This symptom appeared repeatedly in the past 7 days, and the patient transferred to our hospital for further treatment.

Past treatment process: The patient with a history of severe craniocerebral injury was treated with decompressive craniotomy for subdural hematoma and evacuation of devitalized tissue in brain contusion and laceration. Cranial CT showed ventricular enlargement before discharge, but the patient had no clinical manifestations related to hydrocephalus. After the vital signs are stable, the patient was transferred to the rehabilitation hospital. Then the patient came to our hospital to reconstruct of skull defects after two months. Two months after discharge, the patient developed gait disorder and head distension. Taking CT findings into account, the patient was considered to be diagnosed with hydrocephalus [10]. VPS was successfully in the patient with a significant improvement in patient symptoms [10]. The patients were discharged when vital signs were stable.

One month after discharge, the patient was re-admitted to the hospital because of recurrent fever and limb twitching. During hospitalization, there were no similar symptoms and no abnormality in cerebrospinal fluid examination. The cranial CT showed that the size of the ventricle was similar to that before. Then, he was discharged without obvious discomfort.

Current treatment process: During the period of hospitalization, cerebrospinal fluid routine suggested that the white blood cell count was 308/μL and the percentage of neutrophils was 45%. The results of drug sensitivity culture in cerebrospinal fluid suggested that *Staphylococcus aureus* was 100%. On physical examination, the patient showed positive cervical resistance. The result of CT was similar to that of last time. Therefore, we used continuous lumbar cistern drainage combined with systemic intravenous antimicrobials (vancomycin) to treat intracranial infection. However, on the fourth day after operation, the drainage tube was removed because of blockage. Then, the patient developed somnolence and cognitive impairment. We considered that the aggravation of hydrocephalus may cause by intracranial infection. Therefore, we performed VPS removal and EVDs in emergency. The symptoms of the patients were significantly improved. After operation, the results of cerebrospinal fluid showed that the infection control was stable and the disease was fully communicated with the family members. After obtaining the consent of the family members, the external drainage tube was removed and VPS in the temporal horn was performed on the 16th day after operation. Due to the history of severe craniocerebral injury and chronic hydrocephalus, the compliance of the ventricle was decreased, and the ventricle was larger than that of the normal person. Postoperative cerebrospinal fluid pressure was in the normal range. Up to now (five months after the second VPS), there is no obvious discomfort in the patient.

Discussion

Hydrocephalus is one of the most common diseases in the field of neurosurgery, and any intracranial disease may be the cause. Depending on the severity of hydrocephalus, patients may have symptoms such as dizziness, headache and even memory disorders [1].

Intracranial infection is one of the common causes of hydrocephalus [2]. The molecular mechanism of hydrocephalus with intracranial infection is being further studied. One has been clear that TLR plays an important role in this process [11-13], and related targeted drugs are under research. Surgical treatment is still the best way to treat hydrocephalus at this stage [4,14-16]. Some scholars have compared the two commonly used shunt techniques: VPS and Endoscopic Third Ventriculostomy (ETV). There was no significant difference in the overall prognosis between the two shunts, and the treatment failure rate of VPS was slightly lower than that of ETV (24% *vs.* 35%) [17]. Moreover, ETV requires more advanced technical expertise [18]. This also leads to the reason why ETV cannot be widely carried out.

The common complications after ventriculoperitoneal shunt are infections, subdural hematoma and hygroma [19]. Among them, infection is the most common complications which is the main cause of poor prognosis as well [14,15]. A retrospective study showed that infection after VPS was significantly independent of gender, age, and the incidence of hydrocephalus [20]. Within pathogenic bacteria, coagulase-negative *Staphylococcus* is the most common (78%) [21]. The study conducted by Atiqur Rehman showed that the incidence of infection after VPS was 70% in 2 months and 90% in 9 months [22]. Another retrospective study also showed that infection was more likely to occur within 2 months after surgery [23]. Early application of antibiotics and attention to aseptic operation can effectively avoid or reduce the occurrence of postoperative infection [24]. However, there are no convincing guidelines on the timing and whether shunt should be removed after infection [25]. Schreffler et al. [5] have conducted a decision tree analysis, and they point out that protocol of shunt removal, external ventricular drainage placement or ventricular taps and antibiotics followed by creation of a new shunt when CSF is sterile, it is the best way to deal with infection after shunt [5]. Studies by Qin et al. [23] have also shown that patients with totally removal of the catheter after infection have a better prognosis. Although there are no specific guidelines, these studies [5,23] have shown that it is more beneficial to remove the shunt device in a timely manner.

The difference is that it is still unknown when the catheter will be replaced after the shunt device is removed. Most clinicians choose to treat the intracranial infection first and perform shunt surgery until the intracranial infection is completely controlled. There is no doubt that this is a relatively safe way to deal with it. Especially when the progression of hydrocephalus is slow. However, once hydrocephalus causes disturbance of consciousness or other neurological disorders, the shunt of hydrocephalus and the control of intracranial infection become the focus of contradiction.

So, is it possible to perform VPS at an early stage when intracranial infection is under control? As the two cases we have presented, both patients suffered from hydrocephalus with intracranial infection, and hydrocephalus deteriorates so rapidly that EVDs had to be performed before the intracranial infection was completely controlled. EVDs can only provide temporary relief, and the risk of infection increases greatly with the extension of storage time [7-9]. In order to maximize the control of intracranial infection for safe operation, we extend the placement time of EVD as long as possible. However, the control of intracranial infection in two patients has not reached a complete degree [5,6]. If you did not operate as soon as possible, it was likely to lead to brain hernia and life-threatening. Therefore, we performed VPS in the early stage of intracranial infection control (in a relatively stable state). We have also considered inserting Ommaya. Due to the high infection rate of Ommaya insertion (multiply repeated extract CSF from the capsule), we finally chose VPS. Certainly, whether replacing VPS with ETV is effective or not needs further research. Of course, this is just our single-center experience. Due to the small sample size of this treatment mode, a large sample randomized trial is needed.

Conclusion

This case demonstrates that early (In the early stages of intracranial infection control) VPS is an effective and safe treatment for patients who with intracranial infection complicated with hydrocephalus. At the same time, continuous intracranial anti-infective treatment is also necessary. However, this is only our single-center experience, and further controlled trials are needed to further evaluate the effectiveness and safety of early surgery in this patient population. Our report may be a good start to inspire further research and the development of persuasive clinical guideline in the future.

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