

Case Report

Long-term Low-Pressure Hydrocephalus after Ventriculoperitoneal Shunt: A Case Report

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Abstract

Low Pressure Hydrocephalus (LPH) is rare after ventriculoperitoneal shunt (VP). In our study, a reported 43-year-old woman had mental disorder and asthenia of limbs for 10 years after VP. Cranial CT suggested ventricle enlargement but smaller prepontine cistern and IV ventricle (Figure 1). The symptoms were not improved obviously after lumbar cerebrospinal fluid drainage, shunt resetting, replacement of low pressure pump for shunt and other measures. LPH was considered to be induced by sinking brain. Following continuous providing of a low-pressure pump shunt, the patient was changed to the Trendelenburg position (the head-down position) to reverse the sinking brain. The patient recovered consciousness finally, and ventricle was reduced to a normal size. The present case report highlights that the rare complication of LPH caused by sinking brain may occur after VP, and the effective method of treatment is provided accordingly.

Keywords: Sinking brain; Low pressure hydrocephalus; Trendelenburg position; Recovery of brain compliance

to ICP changes is an extremely simple method to restore brain compliance.

Introduction

Low Pressure Hydrocephalus (LPH) is a rare complication after ventriculoperitoneal shunt (VP). It is believed in the study that due to the long-term effect of VP, the volume of cerebrospinal fluid and the pressure are reduced in lumbar cistern at the same time. The microgravity environment in the brain is destroyed [1], thus lumbar pressure cannot support the gravity of the brain, leading to the vertical downward shift of cerebral spinal cord and further development into sinking brain, associated with decreased brain compliance. It is characterized as enlarged ventricle, smaller prepontine cistern and IV ventricle, and low intracranial pressure (ICP), which are supported by clinical and imaging evidence. When a patient may be considered as hydrocephalus, and there is no obvious effect after repeated shunt or drainage of cerebrospinal fluid, LPH should be considered at this moment. For the treatment of these LPH patients, it is necessary to carry out shunt after drainage on the premise of restoring the normal size of ventricles and recovering the brain compliance, so as to achieve obvious curative effect. Maintaining patients' the Trendelenburg position for patients and gradually increase the head position according

Case Report

A 43-year-old woman who underwent VP for hydrocephalus 10 years ago was admitted to the hospital due to dizziness and headache accompanied by vomiting for 2 days. After admission, the patient showed somnolence and asthenia in limbs. The brain CT revealed that bilateral ventricles and III ventricle were dilated and hydrated obviously, but the prepontine cistern and IV ventricle were/became smaller in size (Figures 1,2).

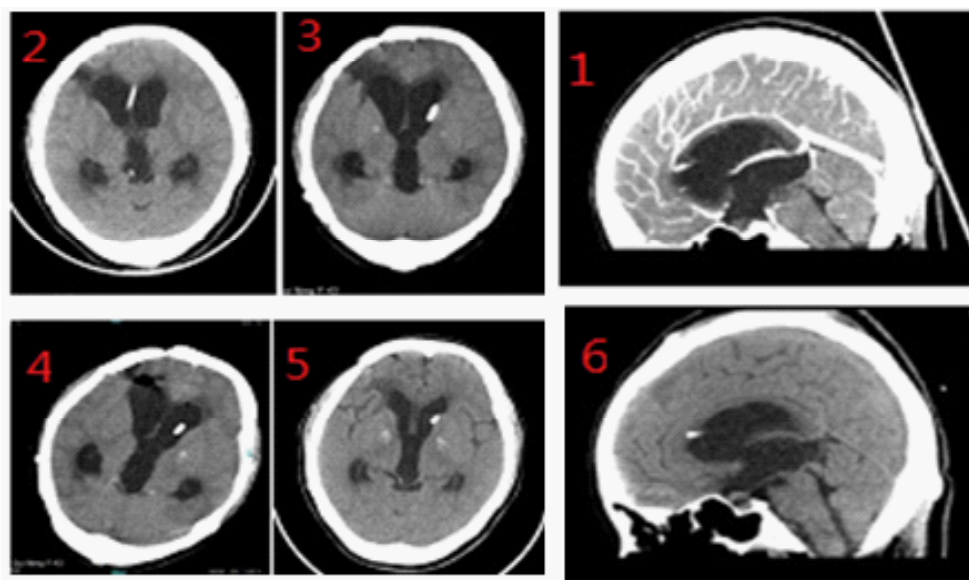
The patient was provided with dehydration, rehydration and other symptomatic support treatment, associated with lumbar drainage of cerebrospinal fluid. The pressure was measured to be 130mmhg. Pressure measurement by compression of the neck suggested that the cerebrospinal fluid circulation was unobstructed, but the symptoms were not significantly relieved in the patient. VP into the left ventricle was thus performed. By taking puncture of frontal angle on the left side, clear cerebrospinal fluid flowed slowly after successful puncture, suggesting that intraventricular pressure was not high. The patient was connected with Medtronic uncontrollable valve pump for adults (Pressure at 70-90mm water

column). On the first day after the operation, the patient had nausea and vomiting, the bilateral pupil diameter expanded to 4.0mm, accompanied by light-reflex retardation and deeper state of consciousness than before. The patient was in a state of light coma. Emergency reexamination of craniocerebral CT showed no obvious remission of hydrocephalus, and the brain ventricle shunt was in position (Figure 3). The function of the shunt pump was checked, and the dehydration was strengthened when the pump started to promote the shunt, and then the consciousness of the patient was briefly improved.

After continuing to strengthen dehydration and pressing pump to promote shunt, the state of consciousness deepened again in the patient. Considering the low pressure of cerebrospinal fluid, Medtronic low pressure shunt pump (30-50mm water column) was replaced since the middle and low-pressure pump shunt was ineffective. Intraventricular puncture and catheterization during the operation showed that the pressure of cerebrospinal fluid was

low, cerebrospinal fluid became visible when the drainage tube was placed low at the level of external auditory canal. The state of consciousness in the patient was significantly improved on the day after operation. However, on the second day after operation, the consciousness of the patient decreased again. Re-examination of the brain CT indicated dilatation of bilateral ventricles and III ventricle, as well as aggravation of hydrocephalus (Figure 4).

After pumping 15ml of cerebrospinal fluid via shunt pump, the patient's consciousness was slightly improved. It was considered that the patient had LPH caused by sinking brain, so the patient was then asked to keep the head down position, and the state of consciousness was improved than before in the patient. The brain CT re-examination revealed clear prepontine cistern and IV ventricle, as well as obvious shrinkage of the ventricle (Figures 5,6). Finally, the patient recovered her consciousness, and the ventricle retracted to the normal size.



Figures 1,2: Before treatment, bilateral ventricles and III ventricle were dilated and hydrated obviously, but the prepontine cistern and IV ventricle were smaller in size; **Figure 3:** Following the replacement of ventricle shunt tube, reexamination of craniocerebral CT showed no obvious remission of hydrocephalus, and the brain ventricle shunt was in position; **Figure 4:** After simple replacement of the low pressure pump, re-examination of the brain CT indicated dilatation of bilateral ventricles and III ventricle, and aggravation of hydrocephalus; **Figures 5,6:** Following the maintenance of Trendelenburg position under the condition of continuous cerebrospinal fluid shunt, brain CT re-examination revealed clear prepontine cistern and IV ventricle, as well as obvious narrow of the ventricle.

Discussion

The development of low pressure hydrocephalus is extremely hidden with low ICP as the cornerstone of the disease, but the clinical manifestation is similar to those with high ICP. Patients usually have headache, nausea, vomiting, and decline in consciousness. There will also be motor or sensory dysfunction, change of consciousness, and even brain hernia. The normal cerebrospinal fluid pressure is 60~180 mmH₂O, while for ICP it is lower than 6 mmH₂O or even less than 0 during hydrocephalus.

Then, what are the causes of low pressure hydrocephalus? The main reasons are listed as follows: firstly, the existence of fistula in the subarachnoid space; secondly, extensive obstruction in the subarachnoid space; and thirdly, decreased compliance of brain tissues. The first two cause the pressure gradient, and the third one is the material basis for low pressure hydrocephalus formation [2]. Some scholars have proposed that the principle of treating this kind of hydrocephalus is to decrease the size of ventricles firstly, and then stabilize the size of the ventricles, and finally to be treated with shunt or external drainage [3]. This order of treatment is vital, and possible reason may be that the material basis of low pressure hydrocephalus formation can be destroyed only by narrowing the ventricle, relieving the pressure of brain tissues, stabilizing the size of ventricles and restoring the compliance of brain tissues. The measures to be taken are: a) Exploration of approach for cerebrospinal fluid fistula closure possibly; b) Release of subarachnoid and ventricular obstruction or performance of endoscopic third ventriculostomy; c) The increase of subarachnoid space pressure, such as rehydration, cervical collar treatment, maintaining Trendelenburg position, and the increase of venous pressure as conservative treatment measures; d) Brain tissue expansion using low pressure ventricular drainage [4].

It is difficult to find fistula since it is usually small and hidden, but increasing the pressure of subarachnoid space is convenient by contrast. In this case, method of changing patients' position was utilized to keep them in Trendelenburg position, and that is to change the micro-gravity environment in the brain, so as to prompt the brain shift to the reverse direction of foramen magnum by gravity, and to improve the sinking brain. The Trendelenburg position can also redistribute cerebrospinal fluid into the cranial cavity during cerebrospinal fluid circulation, and then increase the pressure of subarachnoid space. In such way, the pressure of subarachnoid space is higher than that of ventricle, resulting in pressure gradient, closure of the fistula, smaller ventricles, and thus bulging of brain tissues. Consequently, the therapeutic effect of VP was immediately reflected after the recovery of brain compliance.

The key to reduce ventricular size and restore brain

compliance is the regulation of pressure gradient. The pressure of the ventricle must be lower than that of the subarachnoid space, so that the fistula can be closed. The newly developed shunt pump abroad has a programmable pressure regulator, which regulates the tilt angle of the bed according to the changes of the ICP, thereby changing the position of the patient and forming a pressure gradient. Besides, ventriculo-thoracic shunt is also an available choice due to the negative pressure in the chest cavity, which is, however, the last step [5].

Conclusion

The case report reported a case of LPH reduced by sinking brain 10 years later after VP. Timely diagnosis of LPH is critically important. LPH should be immediately considered when patients have hydrocephalus symptoms accompanied by ineffective repeated drainage or shunt. The effective method is to adjust the position of the patient to maintain the Trendelenburg position and to increase the head position gradually according to the changes of ICP. Accordingly, the cerebral spinal cord of the foramen magnum can be reversed by gravity firstly, and then the cerebrospinal fluid can be redistributed in the cranial cavity and the pressure gradient is formed consequently. With the effect of the two aspects, the compliance of brain tissues can be restored, and the ventricle becomes smaller. Therefore, keeping the Trendelenburg position is a simple and effective treatment for LPH patients. The negative pressure hydrocephalus is a rare type of hydrocephalus with heavy harmfulness. It is an important link for this type of patients to carry out research on its pathogenesis, to improve its recognition, to pay attention to the adjustment of body position and to restore the compliance of the brain in time.

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