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Overdrainage after ventriculoperitoneal shunting in a patient with a wide depressed skull bone defect: The effect of atmospheric pressure gradient



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ABSTRACT

INTRODUCTION: In patients with traumatic brain injury, an effective approach for managing refractory intracranial hypertension is wide decompressive craniectomy. Postoperative hydrocephalus is a frequent complication requiring cerebrospinal fluid (CSF) diversion.

PRESENTATION OF CASE: A 50-year-old male who underwent decompressive craniectomy after traumatic brain injury. He developed hydrocephalus postoperatively, and accordingly we placed a ventriculoperitoneal shunt. However, an imbalance between the intra- and extra-cranial atmospheric pressures led to overdrainage, and he suffered cognitive disorders and extremity weakness. He remained supine for 5 days to avoid the effect of gravity on CSF diversion. After 20 days, we performed a cranioplasty using a titanium plate. The postoperative course was uneventful, and the patient achieved satisfactory recovery. *DISCCUSION:* The gravitational effect and the atmospheric pressure gradient effect are two factors associated in the ventriculoperitoneal (VP) shunt treatment of hydrocephalus for the patient who had decompressive craniectomy. These effects can be eliminated by supine bed rest and cranioplasty.

CONCLUSION: We herein emphasize the efficacy of VP shunt, supine bed rest and cranioplasty in treating hydrocephalus patients who have undergone craniectomy. A flexible application of these procedures to change the gravitational effect and the atmospheric pressure gradient effect should promote a favorable outcome.

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1. Introduction

Decompressive craniectomy is an effective treatment for intractable intracranial hypertension caused by severe brain swelling or hematoma in patients suffering from serious head injury. Post-traumatic hydrocephalus (PTH) is a common complication that necessitates a ventriculoperitoneal (VP) shunt to divert the accumulated cerebrospinal fluid (CSF). A ventriculoperitoneal shunt for hydrocephalus in patients with a skull defect may lead to excessive sinking at the craniectomy site as a result of the atmospheric pressure gradient, which could be aggravated by diversion of cerebrospinal fluid [1]. For patients with PTH and a concomitant wide depressed skull bone defect, the therapeutic strategy is quite challenging for neurosurgeons. Because there is the atmospheric pressure factor which effect on the decompressive skull bone defect [2]. Herein, we present an unusual case of traumatic brain injury with a wide decompressive skull bone defect due to

* Corresponding author at: Department of Neurosurgery, First Hospital of Jilin University, 71 Xinmin Avenue, Changchun 130021, China. *E-mail address:* itisgmwang@163.com (G. Wang). an overdrainage complication occurring after the VP shunting. Our report is in accordance with the SCARE criteria [3].

2. Case report

A 50-year-old man who was **transferred to our hospital** presented with a 1-month history of unsteady gait and urine incontinence.

One year prior to admission, he had suffered a traumatic brain injury in a traffic accident in which he was knocked down while riding a motorcycle and he fell into a coma immediately. The brain computed tomography (CT) revealed cerebral multiple contusion and subdural hematoma (Fig. 1). Under general anesthesia, an emergency hematoma and contusion cleaning procedure and left decompressive craniectomy was performed via a bilateral-supratentorial approach in our hospital. Postoperatively, the patient achieved favorable recovery, and there was no sensorimotor sequela. However, one month prior to the present admission to our hospital, he developed an unable to walk, and urine incontinence, and his cognitive function progressively degenerated. The brain CT revealed ventricular dilation.

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Fig. 1. Head CT showing cerebral multiple contusion and subdural hematoma.

At admission, upon physical examination the patient showed clear consciousness and could answer common questions. The pupils and relevant reflexes were normal. The surgical scar and skull defect were noted on the left temporal site. The power in the lower limbs according to Medical Research Council grading was 3/5. Bilateral Babinski signs were negative. The neurological function was scored 25 points, in accordance with the mini-mental state examination (MMSE) guide.

A repeated head CT in our department showed local bone defect in the left frontal-temporal-parietal region. The ventricular system was significantly dilated with patchy hypodensity in the anterior and posterior horns of the lateral ventricle; no midline shift was noted (Fig. 2).

We placed a VP shunt. On the second day after the procedure, the patient could walk with the support of relatives. The power in the lower limbs was 4/5. MMSE was scored 28 points.

Six days postoperatively, the condition exacerbated, and he was unable to walk. Examination showed that the patient was fully conscious and he could shake hands as requested. Nevertheless, he did not answer any questions, and the power in the lower limbs according to Medical Research Council grading was 2/5. A large skull defect with flaccid concavity was noted. Bilateral Babinski signs were negative. The MMSE scoring was 19 points.

The head CT showed bilateral ventricular reduction, with the drainage tube and its route clearly visible; the midline structures were shifted to the right (Fig. 3).

The patient was told to remain supine for 5 days, and his symptoms improved. A physical examination showed improvement in extremity muscle strength (grade 3/5), and the skull defect region had returned to a normal shape. The MMSE scoring was 26 points. A head CT showed an elimination of the space between the skull plate and the dura mater, and the appearance was normal (Fig. 4).

In order to maintain a relatively balanced state of the cerebrospinal fluid circulation and intracranial pressure, the patient was told to remain supine for another 9 days. Muscle strength was grade 3+/5, The MMSE scoring was 27 points. Twenty days after VP shunt, a cranioplasty using a titanium plate was performed. Seven days after cranioplasty, the patient was able to walk without external support, and the power in the lower limbs according to Medical Research Council grading was normal (grade 5/5). The MMSE scoring was 29 points. A repeated head CT showed the normal appearance for post-VP shunting (Fig. 5). During a follow-up period of 16 months, the patient's recovery was satisfactory. He could walk freely, complete simple work, and there is no urinary problem. CT scan shows that the VP shunt works well and the brain ventricle is normal (Fig. 6).

3. Discussion

Traumatic brain injury is a severe condition, with a reported mortality rate of 20–30%. Among survivors, the rate of disability with neurologic sequelae is 80% [4,5]. Elevated intracranial pressure induced by brain injury can lead to cerebral ischemia and severe emergencies. For patients with traumatic brain injury, a wide decompressive craniectomy is an effective approach for managing refractory intracranial hypertension. However, PTH is a frequent complication of wide decompressive craniectomy [6].

The most widely accepted treatment for PTH is VP shunting combined with a subsequent cranioplasty, but the efficacy and potential risks associated with this strategy remain under debate [7,8]. Most scholars consider that intracranial excessive accumulation of CSF can lead to a regional cephalocele, supporting the rationale for cranioplasty, and recommend first-stage CSF diversion. Over drainage is an infrequent complication of a functioning CSF shunt, but the risk increases when the patient is upright [9]. Over drainage usually manifests as an orthostatic headache caused by intracranial hypotension, slit-like ventricle syndrome, hygroma, or subdural hematoma [10]. However, in hydrocephalus patients who have undergone a previous decompressive craniectomy, the incidence of overdrainage after CSF diversion increases significantly due to atmospheric pressure.

In patients who have undergone craniectomy, developed hydrocephalus, and been treated with VP shunting, abnormal CSF hemodynamics can be due to the atmospheric pressure gradient, intracranial ventricular pressure, gravity, anti-siphonage, and intraperitoneal pressure. Patients would have a higher risk of complications by undergoing two procedures simultaneously than by undergoing each procedure in staged operations [8].

In our present case, there was a wide depressed skull bone defect and hydrocephalus that made VP shunting the preferred treatment. However, on the fourth subsequent day the patient's condition exacerbated, with intracranial hypotension due to overdrainage suspected. This is because CSF diversion performed before cranioplasty in patients with a large cranial defect and hydrocephalus can result in a caving in of the craniectomy site due to the atmospheric gradient, which can also be aggravated by excessive diversion of CSF and change in the patient's position [2,6]. In our case, the sinking of the tissue led to a large flaccid concavity, mimicking a Download English Version:

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