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Clinical Analysis of Post-traumatic Hydrocephalus

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Objective : Post-traumatic hydrocephalus is a complication of head injury and can present with several different clinical symptoms. However, the developing factors of post-traumatic hydrocephalus and treatment are still not well known. The authors design the study to focus on incidence, causing diseases and treatment of post-traumatic hydrocephalus.

Methods : The 789patients of traumatic head injury followed by admission treatment over 7days from Jan. 1997 to Dec. 2001, were divided shunt group and shunt free group. We analyzed age, sex, causing diseases, developing time of hydrocephalus and effects of shunt operation in post-traumatic hydrocephalus.

Results : The incidence of post-traumatic hydrocephalus for requiring shunt was 9.2% (64cases). Chronic hydrocephalus which developed after 14days of injury was higher incidence (51cases). We found following variables were significiantly related to shunt-dependent hydrocephalus : low GCS score at admission, initial CT finding of traumatic subarachnoid hemorrhage and intracerebral hemorrhage (including intraventricular hemorrhage). The effect of shunt operation was not related with the spinal pressure, but had statistically significant correlation with the response of lumbar drainage.

Conclusion : We conclude that development of hydrocephalus after head trauma is related to low GCS score, intracerebral hemorrhage (including intraventricular hemorrhage) and subarachnoid hemorrhage. The effect of preoperative lumbar drainage has a significiant role in predicting the result of shunt operation in patient with post-traumatic hydrocephalus.

KEY WORDS : Post-traumatic hydrocephalus · Lumbar drainage · Shunt.

Introduction

The incidence of hydrocephalus due to head injury varies from 8~72%, but only 1~4% of these patients requires shunt operation[4]. This condition is due to the dysfunction of perfusion and absorption of cerebrospinal fluid(CSF). Radiologic and pathologic findings reveal that this dysfunction in CSF flow occurs mainly around the cerebral convexity. No definite conclusion has been drawn on the incidence and factors inducing shunt operation due to hydrocephalus after head injury, and much controversy exists on whether shunt operation is needed in patients with hydrocephalus. For the purpose of establishing a treatment protocol, we analyzed the factors inducing hydrocephalus after head injury and its prognosis to determine the causing diseases for hydrocephalus and factors that would aid in clinical improvement after shunt operation.

Materials and Methods

We analyzed the clinical outcomes from 789patients who were admitted to our institute for more than one week from January 1997 to December 2001 due to head injury and could be followed up for at least one year. The patients were divided into those who underwent shunt operation and those who did not. Brain computed tomography(CT) was taken from all patients at the time of admission and again when clinical symptoms worsened or early ventricular dilatation was present. It was checked again before surgery or at discharge and at least once after discharge. Brain magnetic resonance image(MRI) was taken in all patients suspected to have hydrocephalus to evaluate whether hydrocephalus was communicating or non-communicating type. The diagnosis of hydrocephalus was based on the clinical symptoms such as loss of consciousness, walking difficulty, incontinence, and memory loss and radiographic findings such as increased ventricular size, low attenuation around the ventricles. The degree of ventricular dilatation was expressed with the ventricular size index(VSI) in those patients with loss of consciousness. It was divided into mild when the ratio of the medial distance of the frontal lobe at the foramen of Monro level and the bifrontal horn distance measured in the posterior portion of the caudate nucleus on CT was 15~20%, moderate

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when between 20~25% and severe when more than 25%[15,17]. Shunt operation was performed in those patients who had higher than moderate level of hydrocephalus according to VSI, showed the dilatation of all ventricles on CT and MRI, and ventricular reflux on radioisotope cisternography. Lumbo-peritoneal(L-P) shunt was performed in those patients who had communicating hydrocephalus or showed improvement after lumbar tapping. Ventriculo-peritoneal(V-P) shunt was performed in patients with non-communicating hydrocephalus or did not show any improvement even after lumbar tapping. Based on these findings, we evaluated various suspected risk factors of hydrocephalus, ie., gender, age, the status of consciousness at the time of admission, causing disease (presence of hemorrhage) and time of occurrence. We compared these results with those from controls. Statistical analysis was done using Chi-square test, and significance was determined at P-value less than 0.05.

Results

Gender and age distributions

Among a total of 789patients, hydrocephalus was diagnosed in 129patients, among whom shunt operation was done in 64patients (9.21%) with higher than a moderate level of hydrocephalus. The ages ranged from 2 to 89years, and the average age was 49.7±10.5years. No significant difference was present in age and gender in those who underwent shunt operation (Table 1).

Consciousness at the time of admission

The GCS score at the time of admission was divided into 4groups, ie., less than 7points (39patients), between 8~10 (13patients), between 11~13 (9patients), and between 14~15 (3patients). The incidence of hydrocephalus was significantly higher in those patients with low GCS scores at the time of admission (Table 2).

Causing diseases

Among those patients who underwent shunt operation due to hydrocephalus developed after head injury, intracerebral hemorrhage including intraventricular hemorrhage was present in 34patients, traumatic subarachnoid hemorrhage in 14, acute subdural hemorrhage in 5, epidural hemorrhage accompanied by skull fracture in 4, and skull fracture in 3. No organic disease was seen on CT in 4patients (Table 3).

Developing time of hydrocephalus

Hydrocephalus developed acutely within 3days of injury in 3patients, subacutely between 4~14days after injury in 10patients, and chronically after 14days of injury in 51patients (Table 4).

Methods of shunt operation

L-P shunt was performed in 52patients with communicating hydrocephalus developed after head injury and symptomatic improvement before surgery after lumbar tapping. V-P shunt was used in 12patients who had non-communicating or showed no improvement after lumbar tapping after being diagnosed with communicating hydrocephalus.

Spinal pressure, symptomatic improvement after spinal tapping, and outcome after shunt operation

Lumbar tapping was performed in all patients who underwe-

Table 1. Age & sex distribution of head injury patients

Age(years)	Non-shunt operation		Shunt operation		Total
	Male	Female	Male	Female	
2~20	42	21	3	2	68
21~40	120	43	9	3	175
41~60	62	76	14	7	259
61~80	148	8	14	6	249
>80	26	5	5	1	37
Total	498	226	45	19	788

* p-value> 0.05

Table 2. Distribution of patients according to Glascow Coma Scale on admission

GCS(score)	Non-shunt operation		Shunt operation		Total
	Male	Female	Male	Female	
<7	41	23	29	10	103
8~10	78	29	7	6	120
11~13	220	85	7	2	314
14~15	160	89	2	1	252
Total	499	226	45	19	789

* p-value : 0.0015

Table 3. The main diseases of head injury patients

Location	Non-shunt operation		Shunt operation		Total
	Male	Female	Male	Female	
EDH*	54	21	3	1	79
SDH	79	31	3	2	115
Skull fx.**	132	52	3	0	187
T-SAH	83	51	9	5	148
ICH***	97	64	24	10	195
Non organic disease	54	7	3	1	65

* EDH : epidural hematoma, SDH : subdural hematoma, Fx : fracture, T-SAH : traumatic-subarachnoid hemorrhage. ** Skull fracture include basal skull fracture and depression fracture. *** ICH(intra cerebral hemorrhage) include intraventricular hemorrhage

Table 4. Timing of developement of hydrocephalus

Timing	Shunt operation		Total
	Male	Female	
Acute	2	1	3
Subacute	7	3	10
Chronic	36	5	51

Table 5. The result of shunt as related to cerebrospinal fluid pressure

CSF pressure	Improved	No improved	Total
< 180mmH2O	46	5	51
≥ 180mmH2O	6	7	13

* p-value> 0.05

Table 6. The result of shunt as related to the response of lumbar drainage

Response	Improved	No improved	Total
Responded	41	11	52
Not responded	6	6	12

* p-value : 0.0184

nt surgery. Spinal pressure was normal (less than 180mmH2O) in 51patients and high (higher than 180mmH2O) in 13patients. Symptoms improved after shunt operation in 46patients (90%) with normal pressure hydrocephalus. This outcome was better than the improvement seen only in 6patients (46.1%) who had higher than 180mmH2O of spinal pressure before shunt operation (Table 5). And 52patients showed symptomatic improvement after drawing about 50cc of CSF. Among these 41patients (79%) showed symptomatic improvement L-P after shunt operation, which was better than 50% (6 out of 12patients) improvement seen in those patients who underwent V-P shunt operation after showing no improvement after lumbar tapping, showing statistical significance with the p-value of 0.0184 (Table 6).

Discussion

The incidence of hydrocephalus after head injury varies from 8~72%, probably because of the broad interpretation of hydrocephalus. Much confusion exists in deciding the direction of treatment in the presence of ventricular dilatation seen frequently after head injury. It was reported that 1~4% of patients require shunt operation for hydrocephalus developed after head injury[4]. Hydrocephalus should be distinguished from ventriculomegaly which is non-specific expansion of brain ventricles and may or may not accompany hydrocephalus[10]. Hydrocephalus is usually defined as the condition of ventricular dilatation due to the overproduction of CSF and dysfuntion of absorption. It can be divided into communicating and non-communicating type. The former type is brought about due to CSF blockage in the area under the 4th ventricle and induced mainly by subarachnoid hemorrhage or meningitis. The latter type is hydrocephalus brought about due to CSF blockage within the ventricular system such as ventricular tumor, hematoma, and herniation.

Postmortem findings have been reported that support the concept of a blockage of CSF flow around the convexities. Foroglou and Zander described the postmortem examination of an unspecified number of cases of post-traumatic hydrocephalus and found obliteration of subarachnoid spaces with fibrous thickening of the leptomeninges, particularly in the sulci of the convexities, but also in the meninges at the base of the brain[7]. Several mechanisms have been proposed to explain the blockage in flow around the convexities, the major one being subarachnoid hemorrhage.

Foltz and Ward described three patients with head trauma and subarachnoid hemorrhage documented by lumbar puncture[6]. These patients later developed communicating hydrocephalus that was thought to be secondary to adhesive arachnoiditis of the basal cisterns, with subsequent impairment of CSF flow over the cerebral convexities. Blockage of CSF flow also has been associated with skull fractures. Pedersen and Haase used radionuclide cisternography to show that four of five patients with temporal bone fractures had diminished isotope flow on the side of the fracture; two patients with depressed vertex fractures had reduced isotope activity over the convexity underlying the fracture[11]. Simple fractures, however, were not associated with hydrocephalus, and only one of nine cases of hydrocephalus had an associated fracture. Cerebral contusion and edema[11], traumatic intracerebral hematoma[1] also have been suggested as causes of obstruction around the convexities with resulting hydrocephalus. These factors may or may not elevate intracranial pressure.

The incidence of hydrocephalus was higher when lesions due to intracerebral trauma were present. Black reported that the incidence of hydrocephalus was higher in old patients with spontaneous subarachnoid hemorrhage who required more shunt operation, probably because of brain atrophy and ventricular size[3]. But in our study no significant difference was present in age.

After comprehensive evaluation for hydrocephalus using clinical data and data from brain CT, MRI and radioisotope cisternography, we found significant clinical improvement after a spinal tapping performed diagnostically by drainage of 50cc CSF regardless of spinal pressure in patients suspected to have hydrocephalus. We found no significant difference according to age and gender.

For the treatment of hydrocephalus, L-P shunt is used extracranially; thus, the biggest advantage of using this shunt is the fact that it results less complications due to brain damage coming from ventricular tapping such as intracranial hemorrhage[13] and epilepsy[5]. This shunt operation is simple, does not take long time, possible under local anesthesia even in patients with poor condition avoiding general anesthesia, and easy to perform in those patients with no ventricular dilatation such as false brain tumor. It requires fewer shunt exchanging in children. It results in a less chance of inducing mechanical problems such as shunt obstruction and fracture including shunt catheter infection, shunt catheter separation, shunt catheter movement, and organ puncture[4]. It brings about less complications such as slit ventricle syndrome due to the non-physiological overproduction of CSF, secondary adhesion, and chronic subdural hemorrhage[2]. Another advantage of using L-P shunt is the fact that reoperation is needed less frequently because of the anatomical difference that the choroid plexus and brain parenchyme causing catheter obstruction when using V-P shunt are not present in the lumbar subarachnoid area[12]. Thus, the use of L-P shunt is possible for the treatment of traumatic communicating hydrocephalus and is considered a good treatment method. Nonetheless, there is still much controversy over the use of this shunt because it is not possible to evaluate whether the shunt catheter is operating properly after operation and postoperative outcomes do not correlate with radiographic findings[8,9,14,16].

We found no correlation between the spinal pressure increase and postoperative outcomes evaluated to determine whether surgical outcomes were better in patients who showed higher than 180mmH_2O spinal pressure. When we evaluated the correlation among a spinal tap, symptomatic improvement and shunt effect, 79% of the patients who underwent a spinal tap and showed symptomatic improvement also showed significant improvement after shunt operation ($p=0.0184$). Radiographic findings should be taken into account to evaluate the need of L-P shunt operation in patients with communicating hydrocephalus. We confirmed the fact that the test of lowering spinal pressure is important before shunt operation by drainage CSF.

Conclusion

We conclude that the development of hydrocephalus after head injury is related to low GCS score, intracerebral hemorrhage (including IVH) and subarachnoid hemorrhage. The symptomatic improvement after preoperative lumbar drainage has a significant role in predicting the result of shunt operation.

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