CLINICAL ARTICLE

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Efficacy and Rebleeding Risk of Preoperative Ventriculostomy in Aneurysmal Subarachnoid Hemorrhage

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Objective : Despite the widespread use of preoperative ventriculostomy in aneurysmal subarachnoid hemorrhage (SAH), there is no general consensus regarding the risk of bleeding associated with its use before aneurysm repair. This study was conducted to define the efficacy and rebleeding risk of ventriculostomy in aneurysmal SAH.

Methods : The authors reviewed 339 consecutive patients with aneurysmal SAH who were treated at our hospital between January 1998 and December 2004.

Results : Preoperative ventriculostomy was performed on 73 patients for acute hydrocephalus after aneurysmal SAH. The Hunt-Hess (H-H) grades of patients who underwent ventriculostomy were higher. Out of the 73 patients who underwent preoperative ventriculostomy, 58 (79%) demonstrated immediate clinical improvement after ventriculostomy. Of those same 73 patients, 22 (30%) suffered aneurysmal rebleeding, whereas only 11 (4%) of the 266 patients who did not undergo ventriculostomy showed preoperative aneurysm rebleeding. The causes of rebleeding in the 22 patients who underwent ventriculostomy before surgery were related to the ventriculostomy procedure itself, subsequent cerebrospinal fluid (CSF) drainage, angiography and patient care procedures, such as endotracheal suction and nursing care. The mean time interval between SAH and surgery in the patients who underwent ventriculostomy was not statistically different from those who did not receive preoperative ventriculostomies (44.66 compared with 42.13 hours; p=0.73).

Conclusion : The preoperative ventriculostomy improved patients' clinical condition but increased the risk of rebleeding after aneurysmal SAH. When necessary, however, rapid change in transmural pressure during ventriculostomy must be avoided, careful management during ventricular drainage is needed, and surgery should be performed as soon as possible to prevent or reduce the incidence of rebleeding.

KEY WORDS : Ventriculostomy · Subarachnoid hemorrhage · Rebleeding · Intracranial aneurysm.

Introduction

Aneurysmal rebleeding is a leading cause of death and disability in cases of subarachnoid hemorrhage (SAH) due to aneurysm rupture[2,9]. Despite its clinical importance, the risk factors of aneurysmal rebleeding are not clearly defined, and data are controversial. Some studies have demonstrated an increased risk of rebleeding in poor H-H grade patients, whereas others advise CSF drainage only for those patients who have an altered sensorium and who are not improving or are deteriorating[7,11,14]. Theoretically, CSF drainage in patients with, recently ruptured cerebral aneurysm may cause increased transmural pressure across the aneurysmal wall, thereby increasing the likelihood of recurrent hemorrhage[15]. However, McIver et al.[9] reported there is no evidence that preoperative ventriculostomy after aneurysmal SAH is associated with an increased risk of aneurysmal rebleeding when early aneurysm surgery is performed.

Despite the widespread use of ventriculostomy, there is no consensus regarding the increased risk of rebleeding when ventriculostomy is performed before aneurysm repair. This retrospective study was conducted to assess the efficacy and risk of preoperative ventriculostomy in aneurysmal SAH.

Materials and Methods

Study population

We reviewed the medical records of 339 patients with acute SAH who were admitted to our department between January

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1998 and December 2004. Subarachnoid hemorrhage was verified with either computed tomography (CT) scan or lumbar puncture and aneurysms were documented on cerebral angiographic studies. Acute hydrocephalus was diagnosed on a CT scan by neurosurgeons and radiologists. Hydrocephalus was confirmed by calculating the bicaudate index on the CT scan.

Data collection

The age, sex, H-H grade, and the location, shape, and size of the cerebral aneurysm in all patients were examined together with respect to whether or not they had undergone ventriculostomy, and if rebleeding had occurred, how long the interval was, and what outcome they had. Patients were grouped according to whether a ventriculostomy had been performed and the risk and time interval of rebleeding between the two were studied; patients who experienced rebleeding were also grouped and studied according to whether a ventriculostomy had been performed or not. Factors which might have affected rebleeding of a cerebral aneurysm were studied as well.

Statistical analysis

All data were analyzed using a standard statistical analysis system. Data were assessed by examining relationships among explanatory variables and between each of the explanatory variables and rebleeding, using Student's t-test, chi-squared, and Fisher's exact test.

Results

Population characteristics

The patients were graded at admission according to the Hunt and Hess criteria. These are shown in Table 1. The H-H grades of the patient group who underwent ventriculostomy were higher (p=0.021). Seventy-three patients underwent ventriculostomy for acute hydrocephalus after SAH. Twenty-three males (31%) and 50 females (69%) with a mean age of 59.5 years underwent preoperative ventriculostomies, whereas 89 males (33%) and 177 females (67%) with a mean age of 62.0 years did not undergo preoperative ventriculostomy. There were no statistically significant differences in age or sex distribution between the two groups.

Table 1. Hunt and Hess grades at admission with and without ventriculostomy

* H&H grade	Ventriculostomy		No ventriculostomy	
	No rebleeding	Rebleeding	No rebleeding	Rebleeding
I	3	0	31	0
II	4	4	106	8
III	21	6	59	1
IV	13	5	16	1
V	10	7	43	1
total	51	22	255	11

* H&H : Hunt and Hess

Immediate clinical outcome after ventriculostomy

Of the 73 patients who underwent preoperative ventriculostomy, 58 (79%) demonstrated immediate clinical improvement after ventriculostomy, whereas seven patients demonstrated no improvement. Eight patients were worsened and died after to aneurysmal rebleeding (Table 2).

Relationship between ventriculostomy and rebleeding

Of the 73 patients who underwent preoperative ventriculostomy, 22 (30%) suffered aneurysmal rebleeding, whereas 11 (5%) of the 266 patients who did not undergo ventriculostomy experienced preoperative aneurysmal rebleeding (Fig. 1). Preoperative ventriculostomy was associated with a significantly increased risk of rebleeding after aneurysmal SAH ($p<0.0001$).

The mean time interval between SAH and surgery in the patients who did not undergo ventriculostomy was similar to those patients who underwent preoperative ventriculostomy (42.13 compared with 44.66 hours; p=0.73; Table 3).

Table 2. Immediate clinical outcome in patients with ventriculostomy

Hunt&Hess grade	Patients	Outcome			
		Improved	Stationary	Worsened	Surgery
I	0	0	0	0	0
II	4	4(100%)	0	0	2(50%)
III	8	7(87%)	1(13%)	0	3(38%)
IV	34	30(88%)	2(6%)	2(6%)*	11(32%)
V	27	17(63%)	4(15%)	6(22%)*	4(15%)
total	73	58(79%)	7(10%)	8(11%)*	20(27%)

* These patients died after aneurysmal rebleeding

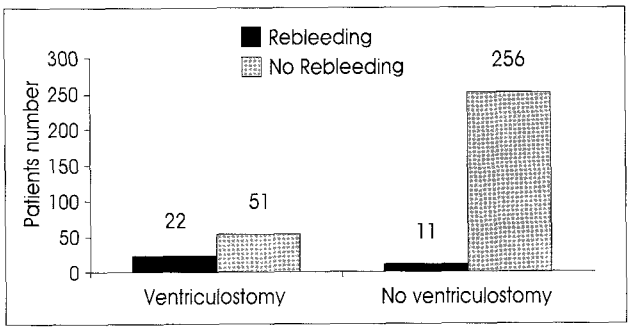

Fig. 1. The rebleeding rates in patients with preoperative ventriculostomy compared with that of the patients without it. The rebleeding rate of the former is higher. The black bar represents no rebleeding and the gray represents rebleeding.

Table 3. Mean time interval between admission and surgery

Hunt&Hess grade	Ventriculostomy			No ventriculostomy		
	No*	Surgery(%)	Time(hours)	No	Surgery(%)	Time(hours)
I	3	-	-	31	25(81%)	71.53
II	8	4(50%)	34.13	114	91(80%)	39.66
III	27	11(41%)	49.58	60	58(97%)	41.93
IV	18	4(22%)	47.03	17	12(71%)	12.07
V	17	1(6%)	24.07	44	4(9%)	7.24
total	73	20(27%)	44.66	266	190(71%)	42.13

* No : number of patients, time : mean time interval

Rebleeding group analysis

No statistically significant differences were found with respect to age, sex, or outcome between the rebleeding group who underwent ventriculostomy and the other rebleeding group, although the mean time interval before rebleeding was shorter in the cases of the former (18.6 hours compared with 36.0 hours).

The events related to rebleeding in the ventriculostomy group were the ventriculostomy itself in eight cases, body weight checking and endotracheal suctioning and intubation in seven, angiography in five, but there were two cases with a non-specific causes. Of the 11 in the non-ventriculostomy group, there were seven cases occurred during angiography, two during suction/physical therapy, and two cases with a non-specific causes (Table 4).

Rebleeding related factors

The risk of rebleeding was higher in order patients (61.9 years compared with 54.2 years, p=0.034), but there were no significant gender difference. On the basis of angiographic findings on 277 patients, there were no difference with respect to location, size, and shape of the cerebral aneurysm between the groups, except for the 62 patients whose conditions did not allow angiography (Table 5). However, H-H grades at admission in the rebleeding group were shown to be higher (p= 0.0331). This indicates that, the worse the patient's condition, the higher the risk of rebleeding (Fig. 2).

Table 4. Clinical features of rebleeding in the patients with and without ventriculostomy

	Ventriculostomy	Without ventriculostomy
Patients	22	11
Sex		
Male	7 (32%)	4 (37%)
Female	15 (68%)	7 (63%)
Mean age(yrs)	63.7	58.2
Rebleeding time (hrs)	18.6*	36
Causes		
	immediately post† : 8 PT and suction : 7 angiography : 5 others : 2	angiography : 7 PT and suction : 2 others : 2
GOS		
Good (4, 5)	1	-
Bad (2, 3)	1	1
Death (1)	20	10

* Two cases were excluded because rebleeding occurred 10 days and 29 days after ventriculostomy, immediately post : †immediately after ventriculostomy, PT : physical therapy, GOS : Glasgow outcome scale, yrs : years, hrs : hours

Table 5. Aneurysmal location, size and shape of patients with and without *rebleeding*

	Rebleeding		No rebleeding	
	Vent.*	No vent.	Vent.	No vent.
Patients	20	9	9	249
Location				
A-com, ACA	6(30%)	4(44%)	3(33%)	79(32%)
MCA	7(35%)	4(44%)	2(22%)	76(31%)
ICA	5(25%)	1(11%)	4(45%)	80(32%)
VA, PCA	2(10%)	0	0	14(5%)
Size(mm)	6.71	7.21	7.88	7.53
Shape				
Saccular	19(95%)	8(89%)	8(95%)	239(96%)
Fusiform	1(5%)	1(11%)	1(5%)	10(4%)

* Vent. : ventriculostomy

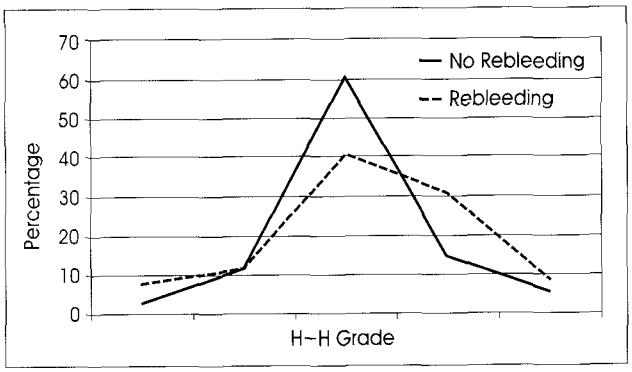

Fig. 2. The comparison between admission Hunt and Hess grades of the patients with rebleeding and those of the patients without. The grades of the patients with rebleeding are higher. The solid line indicates the patients without rebleeding and dotted line represents the patients with rebleeding.

Discussion

It is well recognized that acute hydrocephalus is a common complication of SAH. It is believed that an acute hydrocephalus is formed when the arachnoid villi are obstructed by blood in the acute period following SAH and this could lead to the development of communicating hydrocephalus[7,9,10,18]. The ventricular dilatation is caused by the blockage of the CSF pathways and the fourth ventricular outlet, which are in turn caused by blood and its products in the acute period following SAH[3,11].

The decision to treat acute hydrocephalus may be difficult to make because of several reasons. First, impaired consciousness on admission may result from either the impact of initial bleeding or hydrocephalus. If the impairment of consciousness is caused by hydrocephalus, a delay in the ventriculostomy could lead to a further decrease in cerebral blood flow, precipitating cerebral ischemia. Second, when the decision to carry out ventriculostomy has been made, the question arises as to whether this should be done by ventriculostomy or by internal shunting. Also, ventriculostomy can be associated with serious infection. Third, it has been suggested that early ventriculostomy may precipitate rebleeding, which could be a reason to postpone ventriculostomy until the aneurysm has been clipped[14].

The most common indication for ventriculostomy is poor

clinical grade resulting from a hydrocephalus or ventricular hemorrhage. Poor grade aneurysm patients (H-H grade IV~V) can still achieve a relatively good outcome with active treatment with immediate ventriculostomy and optimal hemodynamic parameters after hematoma evacuation and early occlusion of the aneurysm. Early surgery for good grade aneurysm patients (H-H Grade I~III) is a worldwidely accepted treatment. It has led to the improvement of perioperative management and subsequently to satisfying outcomes[4-6,15,17].

The results of this study show a significantly increased risk of aneurysmal rebleeding in cases of acute hydrocephalus undergoing ventriculostomy. The exact mechanism associated with this is not clear. Cessation of aneurysmal hemorrhage is thought to occur when the intracranial pressure approaches the mean arterial blood pressure after rupture[10-12]. The increased intracranial pressure allows diastolic arrest of the hemorrhage and platelet aggregation at the ruptured site. Lowering the intracranial pressure during the period following aneurysm rupture has been proposed to increase transmural pressure across the aneurysmal sac. Therefore, ventricular drainage for acute hydrocephalus after aneurysmal SAH may result in a higher risk of rebleeding[6,13,14].

However, the risks of rebleeding after ventriculostomy in patients with aneurysmal SAH are still being debated. Some study results indicate that ventricular drainage for hydrocephalus following SAH is associated with a higher risk of rebleeding compared with no ventricular drainage[1,6,8,13,14,16]. Pare et al.[14] reported ventricular drainage, clinical grade, and aneurysm size as potential risk factors for aneurysmal rebleeding. These authors have emphasized that hydrocephalus corresponded with large aneurysmal tears, which were more likely to re-rupture during increases in the transmural gradient, and cautioned that the need for ventricular drainage might reflect a more severely disrupted aneurysm more prone to rebleeding.

In contrast, several authors reported incidences of rebleeding after ventriculostomy from 0 to 14%, but there were no control groups for comparison[3,15]. McIver et al.[9] have stated that there was no statistically significantly increased risk of rebleeding in patients who have undergone ventriculostomy for acute hydrocephalus after SAH. Moreover, the interval between aneurysmal rupture and repair in both group was similar. The goal of their study was to treat the aneurysm early and definitively with surgery or by endovascular means and this might have reflected their results. However, their study excluded patients with untimely dead or a decision made by family or healthcare workers not to transfer them for treatment.

In this study, the mean time interval between SAH and surgery in the patients who did not undergo ventriculostomy was not significantly different compared with those patients who underwent preoperative ventriculostomy. However, preoperative ventriculostomy is associated with an increased risk of rebleeding after aneurysmal SAH. It indicates that ventriculostomy might increase the risk of rebleeding regardless of whether early surgery is performed or not.

The admission H-H grades of the patient group who underwent ventriculostomy were high, and this seemed to increase the risk of rebleeding since it had a shorter mean time interval before rebleeding and a subsequently poor natural course. Regards to this, Kawai et al.[6] also reported the higher the grades, the greater the risk of rebleeding.

Among the causes of rebleeding in the patients who underwent ventriculostomy, there was a small change in intracranial pressure, specifically caused by nursing care, such as endotracheal suction, body weight check, physical therapy, and intubation. Voldby et al.[19] reported that ventricular drainage of CSF to a level of 25mmHg did not increase the rate of rebleeding. Rapid CSF drainage has previously been implicated in rebleeding. With respect to optimal drainage of CSF, McIver et al.[9] suggested that, when a ventriculostomy is performed, the drainage must be carefully monitored and moderate levels of CSF drainage should be implemented initially. Authors agree with their opinions and would like to emphasize that meticulous care to be taken when treating patients with aneurysmal SAH who undergo ventriculostomy.

Conclusion

The results of our study indicate that ventriculostomy increases the risk of rebleeding in aneurysmal SAH. However, careful monitoring and meticulous care following ventriculostomy will provide a better outcome for the patients. Also, surgery should be performed as soon as possible after ventriculostomy.

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Commentary

In this interesting article, the authors analyzed the effect of preoperative ventriculostomy in aneurysmal subarachnoid hemorrhage (SAH). They confirmed the positive effect of this operation on patients' clinical condition and the negative effect on the risk of rebleeding after aneurysmal SAH in a comprehensive way.

The insertion of an external ventricular drainage (EVD) in patients with acute hydrocephalus secondary to aneurysmal SAH, particularly in patients of poor clinical grade is a necessity; this maneuver will immediately improve the clinical grade of these patients, make them better surgical candidates and allow definite surgical or endovascular intervention. However, abrupt lowering of the intracranial pressure could lead to rebleeding due to decreased transmural pressure or removal of the clot sealing the previously ruptured aneurysm. The maintenance of ICP above 15-20mmHg and timely prompt intervention can minimize the risk of rebleeding. A risk which is definitely increased in patients with prolonged EVD compared with ones without it.

In my recent review of the literature, a number of clinical trials have failed to provide evidence for the negative role of EVD in the development of rebleeding. A variety of parameters that could affect the rebleeding rate, such as the timing of surgery, the timing and duration of drainage, the size of the aneurysm, as well as the severity of the initial hemorrhage, do not seem to have been adequately explored in the majority of these studies.

So I think further long-term multi-center studies are required in order to establish the exact nature of the relationship between ventriculostomy and rebleeding after aneurysmal SAH. Multi-institutional, prospective, large clinical series are required for defining the role of the aneurysmal size, as well as the admitting clinical grade in the relationship of rebleeding and EVD.

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