

# Intracerebral Hemorrhage Remote from the Site of Aneurysm Surgery

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## = Abstract =

In order to find out possible causes and measures for prevention of intracerebral hemorrhage remote from the site of cerebral aneurysm surgery, the authors analyzed five patients who developed such a complication following aneurysm surgery among 720 surgical cases of cerebral aneurysm. The aneurysm sites were posterior communicating artery(Pcom) in two cases, anterior communicating artery(Acom) in two, and Acom and middle cerebral artery(MCA) in one. The hemorrhages in three cases occurred in the cerebellum, one in the contralateral hemisphere and one in the ipsilateral hemisphere to the operation site. All hemorrhages except one occurred between 15 and 23 days following an aneurysm rupture and three of five cases showed ischemic symptoms due to vasospasm preoperatively. Fluctuation of blood pressure with sudden elevation to a high level was noticed in three cases preoperatively and in all cases postoperatively.

We conclude that sudden elevation of blood pressure during the remission stage of vasospasm seems to be a possible cause for remote hemorrhage. To prevent this complication, we recommend meticulous control of blood pressure during surgery and in the postoperative period, especially in cases that showed fluctuation of blood pressure preoperatively.

**KEY WORDS :** Blood pressure · Cerebral aneurysm · Postoperative hemorrhage · Remote site · Surgery.

## Introduction

Many kinds of surgical complications can develop following an operation for an intracranial aneurysm. Postoperative intracerebral hemorrhage(ICH) remote from the site of aneurysm surgery is one of these complications<sup>3)</sup><sup>10)3)18)</sup>. Although the incidence of this complication is rare, the result of this complication is associated with a high morbidity and mortality rate<sup>3)10)18)</sup>. We reviewed 5 cases that developed this complication following aneurysm surgery. We tried to find out the possible causes of this complication and, based on results of this study, we suggest methods to prevent this complication.

## Material and Methods

Among seven hundred twenty patients who underwent

surgery for cerebral aneurysms from Sept. 1982 to Jan. 1995, five patients developed postoperative ICH remote from the site of surgery. The medical records of these 5 patients were reviewed, and we examined the relationship between the occurrence of this complication and the following factors : 1) the timing of aneurysm surgery, 2) the presence of preoperative ischemic symptoms due to cerebral vasospasm, 3) a previous history of hypertension, and 4) preoperative, intraoperative, or postoperative hypertension. The authors also investigated sites of ICH formation, management methods, and outcome of the patients.

## Results

### 1. Incidence, clinical features, sites of aneurysms, and the timing of surgery

Among 720 cases who underwent intracranial aneurysm surgery, five cases(0.7%) developed ICH remote from the

surgical site. There were two men and three women ranging from 48 to 69 years(mean age, 59 years). The clinical grades(Hunt and Hess<sup>8)</sup>) on admission were grade II in 2 cases and III in 3 cases. The sites of aneurysms were Pcom in two cases, Acom in two, and Acom and MCA in one. The timing of surgery was delayed in 4 cases, and early in one. Three of five cases showed preoperative ischemic symptoms secondary to cerebral vasospasm(Table 1).

## 2. Medications and the existence of hypertension

All patients were medicated with calcium channel blocker (nimodipine) and four of five patients were infused plasmanate(1000ml/day) for preventing development and/or improving the ischemic symptoms secondary to cerebral vasospasm. Fluctuation of blood pressure with sudden elevation to a high level was noticed in four patients during the postoperative period(ranging from 180 to 230mmHg systolic) and in three patients during the preoperative period (ranging from 160 to 190mmHg systolic).

One patient developed this complication after hypertension(160mmHg) was induced with dopamine infusion for improving the neurologic deficit caused by cerebral vasospasm on the third postoperative day. Four of the

five patients exhibited hypertension during the first 24 hours after surgery. Two patients had a previous history of hypertension(Table 2).

## 3. Timing of the detection and sites of remote intracerebral hemorrhage

The timing of the detection of remote ICH in four patients was between 15 and 23 days after the onset of a subarachnoid hemorrhage(SAH). In one patient, it was 5 days following a SAH. The time interval between surgery and detection of remote ICH was from one day to five days. Clinical evidence of hemorrhage was noticed in the first postoperative day in 2 patients, the second, third, and fifth postoperative day in each of the other patients.

The sites of the remote ICH were ipsilateral hemisphere to the operation site in one patient, contralateral hemisphere in one and cerebellum in three(Table 3).

## 4. Management and outcome

Management methods of patients with remote ICH were surgical evacuation of the hematomas in two cases, ventriculo-peritoneal(V-P) shunt in two, and conservative therapy in one. Those cases with placement of a V-P shunt had hemorrhages in the cerebellum, which caused

**Table 1.** Clinical features, sites of the aneurysms and the timing of surgery#

Case	Age (yr)	Sex	Grade on admission	CT grade	Aneurysm site		Preop. vasospasm Sx.	Grade on op.	Op. days*
1	69	F	III	III	Pcom.	Rt	Yes	II	17
2	67	F	II	III	Pcom.	Lt	None	IV**	12(1)***
3	48	M	II	II	Acom.	Lt	None	II	2
4	51	F	III	II	Acom.	Lt	Yes	III	16
5	60	M	III	III	Acom.	Rt	Yes	IV	14

MCA. Rt

# : Grade : Hunt and Hess clinical grade<sup>8)</sup> ; CT grade : according to Fisher classification<sup>4)</sup>.

Abbreviation : CT=computed tomography ; op=operation ; Pcom=posterior communicating artery ; Acom=anterior communicating artery ; MCA=middle cerebral artery.

\* : after subarachnoid hemorrhage.

\*\* : after rebleeding.

\*\*\* ( ) : day after rebleeding

**Table 2.** The medications and the existence of hypertension#

Case	Medications			Hypertension		
	Nimodipine	Plasmanate	Preop. Hx	Preop.	During op.	Postop.
1	Yes	Yes	None	Yes	None	Yes
2	Yes	Yes	None	None	None	Yes*
3	Yes	None	Yes	None	Yes	Yes
4	Yes	Yes	None	Yes	None	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

\* : Induced hypertension up to 180 mm Hg systolic with infusion of dopamine performed to improve the right hemiparesis caused by cerebral vasospasm.

# Abbreviation : op=operation ; Hx=history.

**Table 3.** The timing of the detection and occurrence sites of the remote hemorrhage

Case	Timing		Occurrence site
	After SAH (day)	After operation (day)	
1	18	1	Contralateral temporal lobe
2	23(5)*	5	Ipsilateral temporo-parietal lobe
3	5	3	Cerebellar hemisphere. Lt
4	18	2	Cerebellar vermis
5	15	1	Cerebellar hemisphere

\*( ) : after rebleeding

hydrocephalus.

Final outcomes<sup>9)</sup> were good recovery in three cases, severely disabled in one and death in one. The two cases managed with surgical evacuation of the hematoma resulted in severely disabled or death. These cases exhibited poor clinical states prior to evacuation of the hematomas (Table 4).

**Table 4.** Management methods of the remote hemorrhage and outcomes

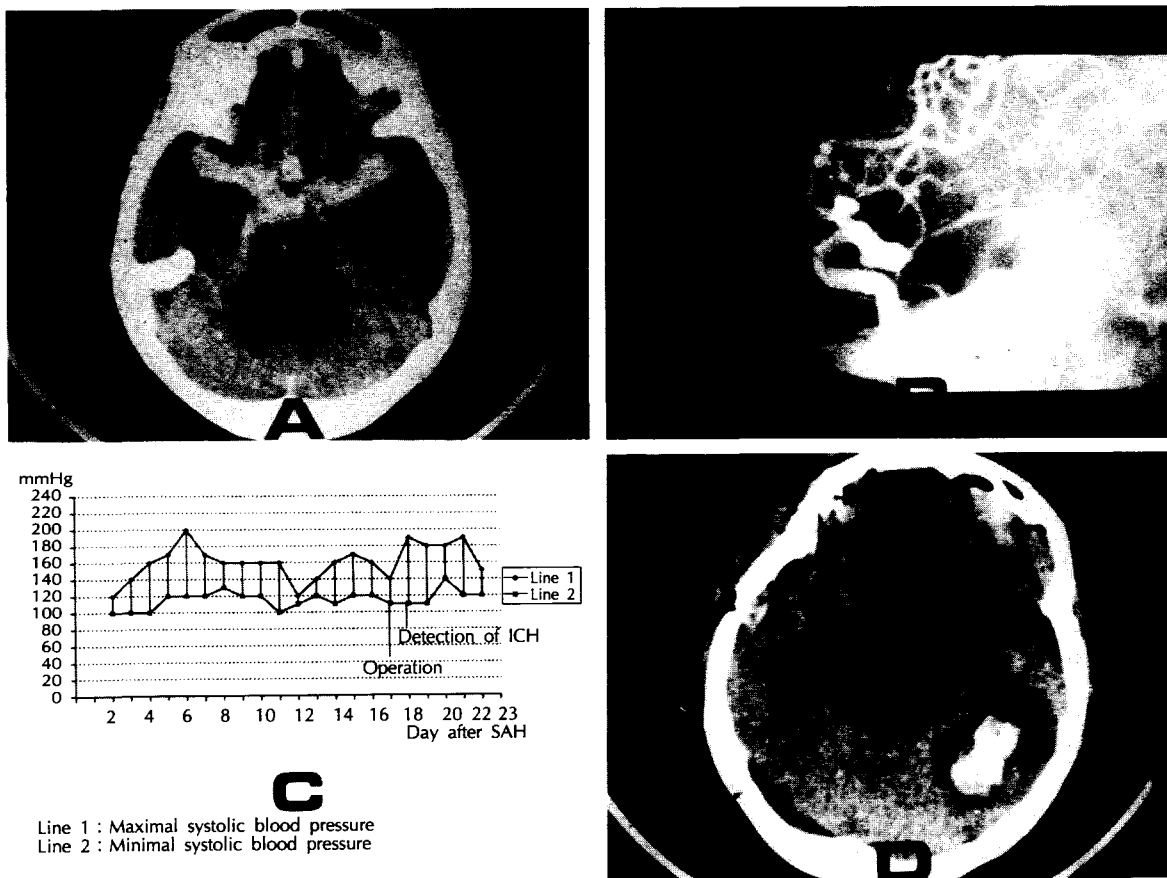
Case	Management method	Outcome*
1	Conservative	Good recovery
2	Surgical removal	Severely disabled
3	Ventriculo-peritoneal shunt	Good recovery
4	Ventriculo-peritoneal shunt	Good recovery
5	Surgical removal	Death

\* : Glasgow outcome scale<sup>9)</sup>

## Illustrative Case Reports

### 1. Hemorrhage in the contralateral hemisphere to the operation site in delayed surgery.

Case 1. This 69-year-old woman was admitted because of a sudden onset of severe headache followed by a transient loss of consciousness in Hunt-Hess grade III status. She had no previous history of hypertension. Computed



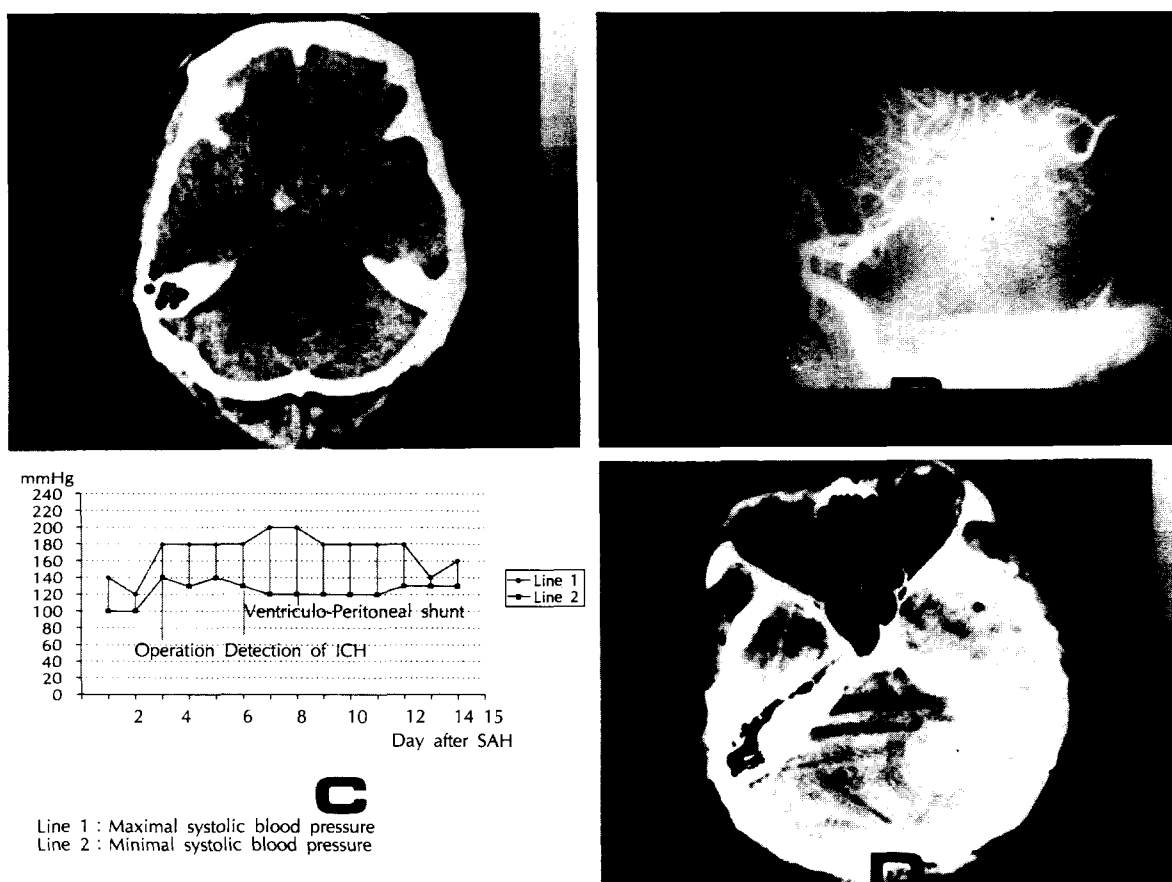
**Fig. 1.** A) Brain CT shows thick SAH in all of the basal cisterns.  
 B) Right internal carotid artery(ICA) angiogram, lateral view, demonstrates a right Pcom aneurysm.  
 C) Systolic blood pressure changes in Case 1. Fluctuation of systolic blood pressure was noticed during the preoperative period.  
 D) Brain CT, taken the day after surgery(18 days after the SAH) after a sudden elevation of blood pressure up to 190 mm Hg, demonstrates an ICH on the side opposite the craniotomy site.

tomographic(CT) scan, checked on the first day after SAH, revealed thick SAH in the all of the basal cisterns(Fig. 1A). During admission, she showed right hemiparesis, mild to high fever and fluctuation of blood pressure(ranging from 100 to 200mm Hg) since the third day after the SAH. She was managed with infusion of plasmanate(1000ml/day) without induced hypertension in order to improve the neurologic deficits caused by cerebral vasospasm. Cerebral angiography was done on day 15 after the SAH, which demonstrated a right Pcom aneurysm(Fig. 1B). Aneurysm clipping was performed without difficulty on day 17 after the SAH. She was in a clear consciousness state with a right hemiparesis at that time. On the next day after the surgery(18 days after the SAH), she showed a deterioration of consciousness with a fluctuation of blood pressure(Fig. 1C). Brain CT was done, which demonstrated an ICH on the posterior temporal lobe opposite the operation site(Fig. 1D). She was managed con-

servatively and recovered completely without neurological deficit.

## 2. Hemorrhage on the cerebellum following early surgery for cerebral aneurysm.

Case 3. This 48-year-old man was referred to us from a local clinic because of sudden onset of headache while washing his hands and face. He had had a CT scan in another hospital that disclosed blood in the right side of his suprasellar cistern(Fig. 2A). He also had another SAH 15 days prior to admission. He had a previous history of hypertension. Upon admission, the patient was alert and had intense nuchal rigidity but no other neurological deficit. Cerebral angiography, done on the second day following the SAH, showed an aneurysm of the Acom(Fig. 2B). A pterional craniotomy with aneurysm clipping was done on the third day following the SAH without difficulty. Postoperative brain CT, on the day of surgery, re-



**Fig. 2.** A) Brain CT demonstrates blood in the right side of suprasellar cistern.  
 B) Right ICA angiogram, oblique view, shows an Acom aneurysm.  
 C) Systolic blood pressure changes in Case 3. Fluctuation of blood pressure with intermittent elevation was noticed since the day of surgery.  
 D) Brain CT, taken 3 days after surgery(6 days after the SAH), demonstrates intracerebellar hemorrhage with dilatation of the all ventricles. Abbreviation : ICH=intracerebral hemorrhage.

vealed mild brain swelling without evidence of intracranial hemorrhage. His blood pressure fluctuated with intermittent elevation to a high level after the surgery(Fig. 2C). On the third postoperation day(6 days after the SAH), he became drowsy. Brain CT was checked and it revealed intracerebellar hemorrhage with ventricular dilatation(Fig. 2D). A V-P shunt was done. 5 days after the operation and, finally, he recovered completely without neurological deficit.

### 3. Hemorrhage in the cerebellum following delayed surgery for a cerebral aneurysm.

Case 4. This 51-year-old woman suffered from sudden onset of headache followed by a brief loss of consciousness while bathing at her house. She was transferred to another hospital where a brain CT revealed blood in the all basal cisterns(Fig. 3A). She was referred to us from

that hospital with the impression of a cerebral aneurysm rupture. On admission, she was confused and had nuchal rigidity but no other neurological deficit. Cerebral angiography, performed on the second day after the SAH, did not demonstrate a cerebral aneurysm. She was managed conservatively and cerebral angiography was repeated 12 days after the SAH, which revealed an Acom aneurysm with segmental narrowing of both anterior cerebral arteries(Fig. 3B). A pterional craniotomy with aneurysm clipping was done 15 days after the SAH without difficulty. As she awoke from anesthesia, sudden elevation of her blood pressure up to 210 mm Hg systolic was noticed(Fig. 3C). A postoperative brain CT demonstrated a mid-cerebellar hemorrhage with dilatation of the ventricles(Fig. 3D). She was managed with a V-P shunt to relieve hydrocephalus. About 6 months after the SAH, she re-

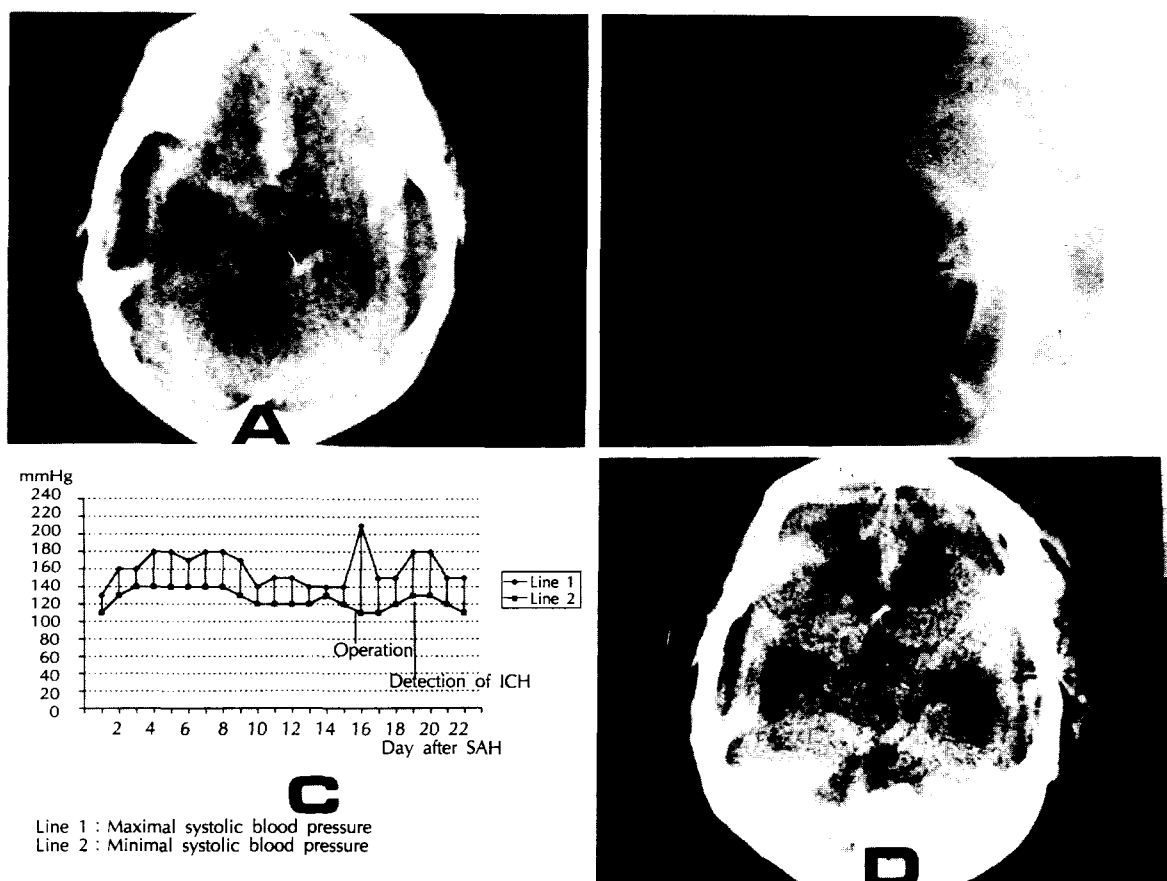


Fig. 3. A) Brain CT demonstrates thick blood in all of the basal cisterns.

B) Left ICA angiogram, oblique view, shows a small aneurysm of the Acom with segmental narrowing of both the anterior cerebral arteries.

C) Systolic blood pressure changes in Case 4. Fluctuation of the systolic blood pressure was noticed during the preoperative period. On the day of surgery, as the patient awoke from anesthesia, sudden elevation of the blood pressure up to 210 mm Hg was noticed.

D) Brain CT, taken 3 days after operation(18 days after the SAH), reveals midcerebellar hemorrhage with dilatation of ventricles. Abbreviation : ICH=intracerebral hemorrhage

covered completely without neurologic deficit.

## Discussion

ICH remote from the site of surgery is fortunately rare<sup>1-3)</sup><sub>5)7)10-11)13-14)18)</sub>. The occurrence of supratentorial ICH after posterior fossa surgery<sup>5)7)10)14)18)</sup>, supratentorial hemorrhage on the side opposite the craniotomy site<sup>1-3)10)13)18)</sup>, and intracerebral and brain stem hemorrhage after evacuation of a chronic subdural hematoma and hygroma<sup>11)</sup> were reported. The incidence of supratentorial hemorrhage after posterior fossa surgery was reported as 0.6%<sup>5)</sup> and 3.7%<sup>7)</sup>. Haines et al<sup>5)</sup> reported five cases that developed such a complication after posterior fossa surgery. Many cases which developed remote ICH after undergoing surgery for a cerebral aneurysm were reported<sup>2)3)13)18)</sup>. Lee and Lee<sup>13)</sup> experienced 16 cases which developed postoperative ICH after surgical management of 640 cases of cerebral aneurysm and, in two cases, the hemorrhage occurred in the hemisphere contralateral to the surgical procedure. Waga et al<sup>18)</sup> reported four cases that developed ICH remote from the site of the initial neurosurgical procedure and, three of them developed following an operation for intracranial aneurysms. In this study, we experienced 5 cases which developed remote ICH after surgical management of 720 cases (0.7%) of cerebral aneurysms.

In the literature, almost all of the remote ICH following aneurysm surgery occurred on the contralateral hemisphere to the surgical site<sup>2)3)13)18)</sup>, and only one case developed a cerebellar hemorrhage<sup>18)</sup>. In this study, however, the remote ICH occurred in the cerebellum in three cases, ipsilateral and contralateral hemisphere in one of each. We do not know the reasons why the remote ICH occurred most frequently in the cerebellum in our cases. The pathogenesis of the remote ICH is unclear. Waga et al<sup>18)</sup> thought sudden and transient increase of the blood pressure during surgery or the perioperative period could be the etiology of the remote ICH. They also regarded hypertension as a predisposing factor for this complication. Benvenuti et al<sup>3)</sup> reported two cases which developed remote ICH following aneurysm surgery and thought that this complication might be from the concurrent effect of many factors, including transient increase of blood pressure, loss of autoregulation of the cerebral blood flow, and drainage of cerebrospinal fluid during surgery. It is well known that cerebral autoregulation is impaired in patients with SAH<sup>6)12)</sup><sup>17)</sup>. A correlation between the degree of vasospasm and the

degree of autoregulation impairment exists<sup>17)</sup>. Relative increase in cerebral blood flow occurs as vasospasm resolves, which in turn increases vascular permeability<sup>15)</sup>. Remote ICH can be induced by fluctuation of the blood pressure at this time. In the literature, patients who developed remote ICH after cerebral aneurysm surgery had surgery more than 10 days after SAH<sup>3)13)18)</sup>.

This period may correspond with the remission stage of the vasospasm. In this study, three of five cases have ischemic symptoms due to vasospasm preoperatively and four of five patients had surgery more than 11 days after the SAH. Fluctuation of blood pressure with sudden elevation was noticed in three cases preoperatively and in all cases postoperatively. We think that sudden elevation of blood pressure during the remission stage of vasospasm seems to be possible cause for remote hemorrhage from the site of the cerebral aneurysm surgery in our cases. However, in Case 2, we can not rule out the induced hypertension for improving the neurologic deficit caused by vasospasm as a possible cause for this complication<sup>16)</sup>.

Management methods of remote ICH depend on the size of the hematoma and the clinical state of the patients<sup>1)</sup><sub>3)5)10)13)18)</sub>. Conservative management can be performed in patients with a small amount of ICH. Surgical management is indicated in patients in poor condition with a large amount of ICH. Mortality and morbidity of remote ICH after aneurysm surgery is serious despite early diagnosis by CT and proper management surgically or medically<sup>3)10)15)18)</sup>. Therefore, prevention is mandatory. We managed our patients with remote ICH by surgical evacuation, V-P shunt and conservative therapy. The final outcomes were good recovery in three cases, severely disabled in one and death in one. To prevent this complication, we recommend that blood pressure be controlled meticulously during surgery and the perioperative period, especially in patients who show fluctuation of blood pressure preoperatively.

## Conclusion

We conclude that sudden elevation of blood pressure during the remission stage of vasospasm seems to be a possible cause for remote hemorrhage. To prevent this complication, we recommend meticulous control of blood pressure during surgery and in the postoperative period, especially in patients who showed ischemic symptoms due to vasospasm preoperatively.

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## 뇌동맥류 수술후 야기된 원격 뇌내출혈

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### = 국문초록 =

과거 13년간 수술적 가료를 시행한 720례의 뇌동맥류 환자중 5례(0.7%)에서 수술부위에서 원격한 부위에 뇌내출혈이 발생되었다. 환자들은 후교통동맥류 2례, 전교통동맥류 2례 및 전교통동맥류와 중대뇌동맥류를 가진 1례였다.

출혈부위는 소뇌 3례, 수술부위의 반대측 대뇌 1례 및 수술부위와 원격한 동측 대뇌 1례였고, 출혈시기는 지주막하출혈후 4례가 15일에서 23일 사이에, 1례가 5일후에 발생되었다. 특징적으로 이들 환자들에서 갑자기 혈압이 고혈압으로 상승하였다가 저하되는 혈압의 유동성이 관찰되었는데 술전에 3례, 술후에 전예에서 관찰되었었다. 또한 이들중 3례에서는 술전 뇌혈관 연축에 기인한 허혈성 증상들을 보였었다. 결론적으로 뇌동맥류수술후 야기되는 원격 뇌내출혈의 원인은 뇌혈관연축의 완화에 혈압의 갑작스런 유동이 원인이 될 것으로 추정되고, 이러한 합병증을 예방하기 위하여서는 수술시 혹은 술후 혈압변동을 최소화하는 것이 필요할것으로 생각된다. 또한 술전에 뇌혈관연축에 기인한 뇌허혈증상을 보였던 환자나 혈압의 유동을 보였던 환자들에서는 이러한 합병증의 발생을 예방하기 위하여 특히 더욱 세심한 혈압조절이 필요할 것으로 사료된다.