

Surgically Treated Anterior Communicating Artery Aneurysm

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Objective : The purpose of this study is to assess the factors related to the outcome of 84 patients who underwent surgery for anterior communicating Artery(ACoA) aneurysms.

Methods : The authors review 84 patients who were undertaken from January 1998 to May 2004. In the management of ACoA aneurysms, the outcome was based on several factors: Clinical condition, Distribution of hemorrhage, Time between aneurysmal rupture and surgery, Direction and shape of the aneurysm.

Results : The incidence rate of the ACoA aneurysm was 35%. Seventy four patients were classified as those having a good recovery, but 5 patients suffered from some morbidity and 5 patients died. The rate of good outcome for the patients with Hunt and Hess grade was as follows 100% in grade I, 95% in grade II, 80% in grade III, IV and V. The rate of good outcome for the patients with Fisher grade was as follows 98% in grade I, II and 81% in grade III, IV. Nineteen of 22 patients who underwent early surgery were rated as good, while twenty six of 30 patients for whom surgery was delayed showed a favorable result. The unfavorable outcomes were also attributed by vasospasm or other medical problems.

Conclusion : For further improvement of the overall surgical outcome: First, early surgical intervention is recommended for good grade patients. Second, active management of poor grade patients should be scrutinized with early surgery. Third, it is also important to step up the effort to minimize the risk of medical complications to enhance surgical results on top of the mainstay of prevention efforts for vasospasm and rebleeding.

KEY WORDS : Anterior communicating artery · Aneurysm · Surgical outcome.

Introduction

The advancement in microsurgical technique and supplemental therapy has improved surgical results in patients with cerebral aneurysm. However, those with anterior communicating artery(ACoA) aneurysm are still subject to high rates of mortality and morbidity. ACoA aneurysm is known as the most common aneurysm form among patients with intracranial aneurysms and accounts for 25~38% of total cerebral aneurysm cases. The success of surgical treatment of ACoA aneurysm is complicated by the fact that the artery is located at the deeper area and surrounded by important structures such as major blood vessels, resulting in a poor prognosis for patients. In addition, the location and direction of aneurysm depends on hemodynamic variables such as the direction of blood flow and the size of blood vessel. All of these factors are important when deciding the surgical treatment and direction,

adding complexity to the procedure^{7,8,19,26}. It is known that the location and direction of aneurysm have an effect on the symptoms and prognosis in patients with cerebral aneurysm. Therefore, this study aimed to determine variables that have an impact on outcomes in patients who underwent surgery for ACoA aneurysm. The study, particularly, focused on identifying factors uniformly applied to those who showed a unfavorable outcome following surgery.

Materials and Methods

Subjects

The study was conducted in 84 patients with anterior communicating artery aneurysm among 240 patients for whom authors performed surgery for aneurysm from January 1998 to May 2004. Patients with ACoA aneurysm made up of 35% of total patients with cerebral aneurysm.

Research method

First of all, treatment outcome of all subjects was assessed based on their age, gender, level of consciousness on admission, the severity of hemorrhage on CT scan, angiographic vasospasm(present or absent), duration between rupture and surgery,

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and aneurysm shape and the direction of the aneurysm. These variables in subjects aged 65 or above were more thoroughly analyzed. And variables in subjects showing a poor outcome were identified to determine the correlation between these factors and treatment outcome. To examine the level of consciousness on admission, the Hunt & Hess classification was used. The severity of hemorrhage was rated according to the Fisher's grade. The diagnosis of hydrocephalus was made based on CT scan findings, and patients with hydrocephalus were divided into the two groups depending on whether they underwent emergency extraventricular drainage before surgery or whether they underwent ventriculo-peritoneal shunt after surgery. The direction of aneurysm was classified into anterior, superior, posterior and inferior depending on the direction in which the aneurysm fundus projected on angiography showing the lateral views of the aneurysm. The timing of surgery for each subject was varied with initial clinical symptoms. Those with less severe symptoms (grade I to III in the Hunt-Hess classification) underwent surgery as soon as possible and those with intracranial hematoma or acute hydrocephalus caused by intraventricular hemorrhage had emergency surgery, whereas unstable patients, including those with semicoma, received non-surgical treatment aimed at improving their conditions to the extent at which they were expected to recover when the surgery was performed. A vasospasm means a case in which the diameter of the intracranial internal carotid artery reduced more than 40%, as suggested in the study by Saito et al²². To treat vasospasm before the surgery was performed, nimodipine was injected intravenously to all patients with vasospasm along with hemodynamic treatments such as fluid therapy and blood pressure control. The surgical treatments chosen for all subjects were performed through a standard pterional approach. For the high positioned aneurysm, the inter-hemispheric approach was used. 82 patients underwent a pterional-transsylvian approach while the remaining two patients had an interhemispheric approach. During surgery, both proximal A1 segments were temporarily clipped, and brain protecting medication was given to patients, in addition to the maintenance of regular blood pressure. The surgical procedure for each site (right or left) was determined by the size of anterior cerebral artery aneurysm, the location of the A2 junction, the location of aneurysm origin, aneurysm direction, intracranial hematoma and aneurysm formation in other locations. The outcomes of all subjects were rated as Good Recovery (GR), Moderately Disabled (MD), Severely Disabled (SD), Vegetative State (VS) and Dead (D) according to individual conditions at discharge using the Glasgow outcome scale (GOS). Favorable outcome means GR, MD. Unfavorable outcome means SD, VS and

dead. The SAS window version 8.01 and Chi-square test were employed for statistical analysis.

Results

Demographics and outcome

The subjects ranged in age from 24 to 76 years. Among 84 patients, 26 were in their 50s, accounting for 31% of total subjects, followed by those in their 40s (30%), those in their 60s (18%) and 2 patients in their 20s (2%). The patients were divided into 40 men and 44 females (1:1.05), showing no significant difference (Table 1).

Of total patients, 71% achieved a good recovery and 17% had a moderately disabled. In other words, 88% of total patients showed favorable outcome, raising the likelihood that they are able to live independently. Five patients died of causes unrelated to the surgery, making up 6% of total subjects. There were 14 patients in their 60s, 10 of which had favorable outcome. As a result, there was no significant difference between age and treatment outcome.

Pre-operative clinical status, the severity of hemorrhage and outcome

The surgical results were not always correlated with preoperative clinical status. In this study, 14 patients were rated as Hunt & Hess grade IV or higher, but 10 patients (71%) showed favorable outcome. Two patients (4%) exhibited a unfavorable outcome among 55 patients with Hunt & Hess grade I and II. Eight patients (28%) had a unfavorable outcome among 29 patients with Hunt & Hess grade III, IV and V (Table 2). As for the relationship between the severity of hemorrhage and pre-operative clinical status, 39 (95%) out of 41 patients with

Table 1. Age and sex

Age(year)	Male	Female	No. of case(%)
21-30	1	1	2(2)
31-40	9	2	11(13)
41-50	16	9	25(30)
51-60	6	20	26(31)
61-70	8	7	15(18)
70-80	0	5	5(6)

Table 2. Preoperative clinical condition(H-H grade) and outcome(GOS)

	GR	MD	SD	VS	D	Total
Grade I	17(5)	1	0	0	0	18(5)
Grade II	31	4(2)	1	0	1	37(2)
Grade III	8(1)	3(2)	3(2)	0	1(1)	15(6)
Grade IV	4	4	1	0	3(1)	12(1)
Grade V	0	2	0	0	0	2

() ≥65 yrs, GR : Good Recovery, MD : Moderately Disabled, SD : Severely Disabled, VS : Vegetative State, D : Dead

Table 3. Preoperative fisher grade and outcome(GOS)

	GR	MD	SD	VS	D	Total
Grade I	3	1	0	0	0	4
Grade II	30(5)	5	1(1)	0	1	37(6)
Grade III	17(1)	4(2)	2	0	2(1)	25(4)
Grade IV	10	4(2)	2(1)	0	2(1)	18(4)

() ≥ 65 yrs, GR : Good Recovery, MD : Moderately Disabled, SD : Severely Disabled, VS : Vegetative State, D : Dead

Table 4. Operation timing and outcome(GOS)

	GR	MD	SD	VS	D	Total
Early(0–3day)	16	3	2	0	1	22
Intermediate(4–7day)	26	3	1	0	2	32
Delayed(>7day)	18	8	2	0	2	30

GR : Good Recovery, MD : Moderately Disabled, SD : Severely Disabled, VS : Vegetative State, D : Dead

Table 5. Vasospasm and preoperative CT finding(Fisher's grade)

	Presence	Absence	Total
Grade I	1	3	4
Grade II	2	35	37
Grade III	10	15	25
Grade IV	6	12	18

Table 6. Aneurysm direction and outcome(GOS)

	GR	MD	SD	VS	D	Total
Anterior	22	6	2	0	1	31
Superior	16	3	2	0	2	23
Posterior	6	3	1	0	1	11
Inferior	16	2	0	0	1	19

GR : Good Recovery, MD : Moderately Disabled, SD : Severely Disabled, VS : Vegetative State, D : Dead

Fisher grade I and II showed favorable outcome, compared with 36 (81%) out of 43 patients with Fisher grade III and IV, showing a significant difference. Thus poor pre-operative clinical status and the higher degree of hemorrhage resulted in unfavorable outcome (Table. 3) ($P=0.0522$). There were 12 patients who underwent emergency extraventricular drainage for hydrocephalus. Six of them showed unfavorable outcomes with the surgery. Two patients underwent ventriculo-peritoneal shunt for hydrocephalus occurred following surgery.

Timing of surgery, surgical approach and outcome

Since most patients were referred from other hospitals after hemorrhage, only 22 patients underwent the surgery within 72 hours following hemorrhage. Among them, 19 patients (86%) achieved favorable outcome while the remaining 3 patients (14%) had unfavorable outcome after displaying worse clinical grades with massive hemorrhage at an early stage or vasospasm. As for the duration between aneurysm rupture and surgery, three (9%) had unfavorable results among 32 patients who underwent the surgery between 4 and 7days, which lied in the middle of the duration range. Four patients

(13%) had unfavorable results among 30 patients whose surgery was much delayed (Table 4). Thus there was no statistically significant difference in treatment outcome in terms of the timing of surgery ($P>0.05$).

Vasospasm and outcome

Nineteen patients had vasospasm based on cerebral angiography undertaken prior to surgery, and 13 patients (68%) of them showed favorable outcome. Given the findings that those with vasospasm resulted in worse outcome than their counterparts, the statistical difference between the two groups was significant ($P<0.05$). Also, there was a significant relationship between the severity of hemorrhage and vasospasm occurred prior to surgery (Table 5).

The direction of aneurysm and outcome

Fifty four patients were in the anterior and superior direction, but there was no significant difference in outcome between groups with different directions of aneurysm (Table 6)($P>0.05$).

Variables related to unfavorable outcome

The analysis of 5 patients who developed severely disabled showed an array of complications associated with massive hemorrhage at the early stage, including cerebral vasospasm. And the analysis of 5 patients who died after surgery showed myocardial infarction, aspiration pneumonia, upper gastrointestinal bleeding, acute renal failure and severe vasospasm. The death of each patient was due to causes unrelated to the surgery.

Discussion

ACoA aneurysm is the most common form of intracranial aneurysm, accounting for 25~38% of total cerebral aneurysm cases^{2,28}. The surgical procedures are technically difficult because the artery is located at the deeper area, surrounded by important structures such as major blood vessels and projected into the diverse direction of aneurysm, leading to unfavorable prognosis in patients^{19,28}. Investigators were divided in their opinions over the best surgical treatment for ACoA aneurysm⁷. With advanced surgical options for the treatment of cerebral aneurysm, the incidence of hemorrhage after surgery was drastically reduced, leading to lower mortality. Despite the advancement in surgical technique, ACoA aneurysm has high rates of mortality and morbidity, promoting the need for further study on variables related to treatment outcome and investigation on patients with unfavorable outcome.

Anterior Communicating Artery Aneurysm

The incidence of aneurysm in the age range was relatively consistent with the findings of other studies^{13,15}. There was no significant difference in the incidence of aneurysm in terms of gender, giving a ratio of 1:1.05. There were 14 patients aged 65 or above, and 8 of them had favorable results, running contrary to previous studies reporting poor results in aged patients^{13,16}. The favorable outcomes is attributable to timely surgery and aggressive therapy in addition to their less severe symptoms before surgery.

The clinical grades (Hunt & Hess grade) at admission had a close correlation with treatment outcome^{4,13,15}. But those with poor clinical grades proved efficacy of surgical treatment in the study and showed favorable outcomes, running contrary to the finding that higher Hunt & Hess grades results in unfavorable outcomes¹³. Such favorable outcomes represent combined influences of timely emergency extraventricular drainage, aggressive treatment of vasospasm, prompt keeping airway for patients with low levels of consciousness, helping patients keep regular blood pressure and other therapeutic strategies aimed for minimizing postoperative complications.

The severity of hemorrhage on CT scanning undertaken before surgery is correlated with unfavorable outcomes. This means that the massive hemorrhage speeds up damage to brain as well as cerebral blood flow and eventually elicit vasospasm, leading to unfavorable outcomes⁴. Therefore, the amount of blood (Fisher grade) present on CT scan is considered an valuable indicator in the prediction of prognosis.

The range of incidence rates of hydrocephalus in patients with cerebral aneurysm proposed in the literature is wide. Some investigators reported as low as 6% while others cited incidence rates up to 30%. They said that patient's older age, intraventricular hemorrhage, higher Hunt-Hess grades at admission and recurring hemorrhage increased the likelihood of developing hydrocephalus^{23,25}. This study identified 12 patients (14%) who presented with hydrocephalus on CT scan. Two of them still showed signs of hydrocephalus after surgery and underwent ventriculoperitoneal shunt.

The timing of surgery is still open to debate among investigators, but there is a tendency toward favoring a surgery within 72 hours after rupture^{17,24}.

Early surgery for cerebral aneurysm is beneficial as it prevents rebleeding, reduces other complications, and accelerates the treatment of vasospasm after surgery. And the hospitalization can be shortened as a result^{7,13,14,20}. Delayed surgery also poses advantages to patients by allowing them to stabilize their clinical status and reducing brain edema and vasospasm^{5,27}. In this study, 19% of patients who underwent surgery within 72 hours after rupture had unfavorable outcomes. All of these

subjects required emergency surgery because of severe damage to brain that followed massive hemorrhage at the early stage.

Among those who got delayed surgery, 14% showed unfavorable outcomes after surgery. While waiting to have surgery, hemorrhage recurred, the level of consciousness aggravated and other complications occurred, contributing to worse clinical results.

Although the mechanism for cerebral vasospasm is not clear, it is assumed that inflammation plays a putative role in the development and maintenance of vasospasm^{6,20}. The larger amount of blood present on CT scan indicates a greater chance of developing vasospasm, whereas the absence of blood or blood spreaded randomly on CT scan findings were unlikely to be associated with vasospasm^{3,18}. Unfavorable outcomes after surgery for patients with cerebral aneurysm are mainly characterized by vasospasm and rebleeding^{12,13}. Those without vasospasm showed better results than their counterparts. The study found that 79% of those with vasospasm had a favorable outcome, which appears to be a consequence of thorough checking and preventive hemodynamic therapy conducted to prevent cerebral vasospasm.

A larger number of aneurysms were in the anterior and superior direction according to Yasargil²⁸ classification system, supporting the findings of other studies¹⁰. The direction of aneurysm poses a frustrating barrier to performing surgery because of its relationship to surrounding blood vessels and may be useful for the prediction of rebleeding¹¹. But there was no significant relationship between the direction of aneurysm and treatment outcome in this study. And the advanced surgical technique is considered to be the main contributor to such good results. For the shape of aneurysm, multilobulated and oval aneurysms exceeded other shapes, although there was no significant difference in treatment outcome in terms of aneurysm shape.

The multiple aneurysm accompanied by the ruptured ACoA aneurysm occurred in 14 of 84 patients, which does not differ significantly from those reported in other studies. It was found that 83.3% of those with multiple aneurysm had favorable outcomes, showing no significant relationship between the formation of a secondary aneurysm and treatment outcome.

After surgery, 24 patients developed complications. Among them, the elderly patients, particularly, experienced lung and gastrointestinal tract-related complications. Those with complications were well treated. Stringent preventive measures and aggressive therapy appears to be vital for favorable outcome in elderly patients who are susceptible to complications.

The major causes of death and morbidity in patients with aneurysm have been cited as the severity of hemorrhage at the

early stage, vasospasm and rebleeding^{18,21}). Authors identified complications (pneumonia, myocardial infarction, upper gastrointestinal bleeding and acute renal failure) and cerebral vasospasm as main causes of death. Therefore, it is also important to step up the effort to minimize the risk of medical complications to enhance surgical results on top of the mainstay of prevention efforts for vasospasm and rebleeding.

Conclusion

For further improvement of the overall surgical outcome : First, early surgical intervention is recommended in good grade patients. Second, aggressive management of poor grade patients should be scrutinized with early surgery. Third, it is also important to step up the effort to minimize the risk of medical complications to enhance surgical results on top of the mainstay of prevention efforts for vasospasm and rebleeding.

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