สารศิริราช
SIRIRAJ HOSPITAL GAZETTE

จัดพิมพ์โดยอนุมัติคณะกรรมการคณะแพทยศาสตร์ศิริราชพยาบาล
Published Under the Auspices of the Faculty of Medicine, Siriraj Hospital

ปีที่ 54, ฉบับที่ 5, พฤษภาคม 2545	Volume 54, Number 5, May 2002

Operative Outcome of Ruptured Saccular Aneurysm of the Anterior Cerebral Circulation at Siriraj Hospital : A Personal Series

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Abstract : **This retrospective study analysed the data regarding the operative outcome of patients who had subarachnoid hemorrhage (SAH) from rupture of a saccular aneurysm of the anterior cerebral circulation. All patients were operated on by the author between July 1997 and November 2001 at Siriraj Hospital.**

A total of 62 patients were included in this study. All patients were assessed on admission using Hunt and Hess classification. There were 5 patients (8.1%) in Grade 1, 12 patients (19.4%) in Grade 2, 37 patients (59.7%) in Grade 3, 7 patients (11.3%) in Grade 4, and 1 patient (1.6%) in Grade 5. A uniform management protocol was used in every patient including intensive cardiovascular monitoring, calcium channel blocker administration, early surgery clipping the aneurysm and aggressive anti-ischemic treatment. There were 22 patients (35.5%) who received early surgery (within 72 hours of the SAH), 12 patients (19.4%) received intermediate surgery (between day 4 and day 6 following SAH) and 28 individuals (45.1%) had late surgery (day 7 or later following SAH).

At 6 months after the SAH, favorable outcome (Glasgow Outcome Scale: GOS 1 and 2) was achieved in 55 patients (88.7%), unfavorable outcome (GOS 3 and 4) in 1 patient (1.6%) and death in 6 patients (9.7%). The causes of death were surgically related in 3 patients (4.8%) and non-surgically related (delayed ischemic complication and sepsis) in other 3 patients (4.8%).

เรื่องย่อ : ผลการผ่าตัดรักษาภาวะการแตกของหลอดเลือดโป่งพองของระบบหลอดเลือดสมองส่วนหน้าในโรงพยาบาลศิริราช : การศึกษาในผู้ป่วยที่ได้รับการผ่าตัดรักษาโดยผู้ศึกษา

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การศึกษานี้เป็นการรวบรวมข้อมูลเกี่ยวกับผลการผ่าตัดผู้ป่วยที่มีภาวะเลือดออกใต้ชั้นเยื่อหุ้มสมอง arachnoid ที่เกิดจากการแตกของกระเปาะโป่งพองของหลอดเลือดส่วนหน้าของสมอง ผู้ป่วยทุกรายได้รับการผ่าตัดโดยผู้ศึกษา ในโรงพยาบาลศิริราช ในช่วงตั้งแต่เดือนกรกฎาคม พ.ศ. 2540 จนถึงเดือนพฤศจิกายน พ.ศ. 2544

จำนวนผู้ป่วยที่ศึกษามีทั้งสิ้น 62 ราย ผู้ป่วยทุกรายได้รับการประเมินสภาวะทางระบบประสาทเมื่อแรกรับไว้ในโรงพยาบาลโดยใช้ Hunt and Hess classification จำนวนผู้ป่วยเกรด 1, เกรด 2, เกรด 3, เกรด 4 และเกรด 5 มีจำนวน 5 ราย (8.1%), 12 ราย (19.4%), 37 ราย (59.7%), 7 ราย (11.3%) และ 1 ราย (1.6%) ตามลำดับ ผู้ป่วยทุกรายได้รับการรักษาโดยใช้หลักเกณฑ์เดียวกัน คือ การดูแลรักษาในหอผู้ป่วยหนัก ทุกรายได้รับยากลุ่ม calcium channel blocker นอกจากนี้ผู้ป่วยทุกรายได้รับการผ่าตัดรักษาอย่างเร่งด่วนหลังจากเข้ารับการรักษาในโรงพยาบาล และได้รับการรักษาสภาวะสมองขาดเลือดจากการหดตัวของหลอดเลือด จากการศึกษาพบว่าผู้ป่วย 22 ราย (35.5%) ได้รับการผ่าตัดรักษาภายใน 72 ชั่วโมง หลังจากการแตกของหลอดเลือดโป่งพอง ผู้ป่วย 12 ราย (19.4%) ได้รับการผ่าตัดรักษาภายในช่วงวันที่ 4 ถึงวันที่ 6 หลังเกิดการแตกของหลอดเลือด และ 28 ราย (45.1%) ได้รับการผ่าตัดรักษาหลัง 6 วัน

จากการตรวจติดตามผลการรักษาที่ช่วงเวลาประมาณ 6 เดือนหลังการแตกของหลอดเลือดโป่งพองนั้น พบว่าการผ่าตัดรักษาให้ผลเป็นที่น่าพอใจ 55 ราย (88.7%) ผลการผ่าตัดไม่น่าพอใจ 1 ราย (1.6%) และเสียชีวิตภายหลังการผ่าตัด 6 ราย (9.7%) สาเหตุของการเสียชีวิตในผู้ป่วยที่ได้รับการผ่าตัด แบ่งเป็นผลจากการผ่าตัดโดยตรง 3 ราย (4.8%) และผลจากภาวะแทรกซ้อน อันได้แก่ ภาวะสมองขาดเลือด และติดเชื้อ 3 ราย (4.8%)

INTRODUCTION

Subarachnoid hemorrhage (SAH) from rupture of aneurysms arising from the circle of Willis is a disastrous condition which kills or disables a substantial number of patients. With advances in microsurgical techniques and other therapeutic modalities, most patients are treated successfully and have the potential to return to normal life. In order to improve the outcome of patients with aneurymal SAH especially from rupture of an aneurysm of the anterior cerebral circulation, knowledge of the causes and incidence of morbidity and mortality in this group of patients should be available.

The purpose of this study was to evaluate the operative outcome of patients who were operated by the author during the study period. An understanding of the details of operative outcome including the incidence and causes of morbidity and mortality will be a good clinical tool for the surgeon because it can be used not only to compare with results from other published studies but also to improve outcome in the future.

MATERIALS AND METHODS

Patient Population

Patients who underwent surgical treatment by the author were included. Only those who were diagnosed with a SAH from rupture of a saccular aneurysm of the anterior cerebral circulation and who were admitted to Siriraj Hospital from July 1997 to November 2001 were included in this study. Information was obtained from patient charts, out-patient records and operative room registration. SAH was diagnosed by computer tomography scan. The presence and details of the aneurysms were diagnosed by four vessel cerebral angiography. The severity of SAH was assessed clinically on admission using Hunt and Hess criteria[1,2] (Table 1).

Table 1. Hunt and Hess scale for clinical grading.[1,2]

Grade	Description
1	Asymptomatic or minimal headache and slight nuchal rigidity
2	Moderate to severe headache, nuchal rigidity, no neurological deficit other than cranial nerve palsy
3	Drowsiness, confusion, or mild focal deficit
4	Decerebrate rigidity and vegetative disturbance
5	Deep coma, decerebrate rigidity, moribund appearance

Management Protocol

Every patient was considered to be a candidate for surgery irrespective of his or her clinical status. Management was unifrom using a standardized policy which included : 1) comprehensive intensive care; 2) invasive hemodynamic monitoring such as a central venous line; 3) adequate sedatives, analgesics, and antiepileptics; 4) surgery to repair the aneurysm as early as possible; and 5) aggressive prevention and management of vasospasm including Triple-H therapy (prophylactic hypervolemia, hypertension and hemodilution) and administration of a calcium channel blocker. Patients with poor clinical grade (Grade 4 and 5) or who needed respiratory support were intubated and ventilated.

Operative Technique

Surgery was performed as soon as possible after careful radiological evaluation. All aneurysms were exposed by a pterional approach except in poor grade-patients, the large frontotemporal craniotomies, rather than a standard pterional approach were usually performed. Aneurysms located at the paraclinoid region or ophthalmic artery aneurysms were exposed through an extradural cavernous approach. A pericallosal aneurysm was exposed through a frontal interhemispheric approach.

Brain relaxation was achieved by continuous administration of intravenous thiopental (3-5 mg/kg/hr) or administration of a bolus dose of osmotic diuretic (Mannitol 1 gm/kg) started just before the beginning of the operation. Acute hydrocephalus present preoperatively was managed by performing ventriculostomy before exposing the aneurysm. A standard microvascular technique and magnification were used in all cases after dural incision. The sylvian fissure was fully opened from the lateral to medial side and from inside out. All aneurysms were clipped using Yasagil or Sugita clips. After clipping, pieces of gelfoam soaked with papaverine solution were applied to the parent vessel and to the adjacent vascular structures. Watertight dural closure was attempted in all cases.

Hydrocephalus

Patients who developed post-operative hydrocephalus were initially treated by lumbar spinal drainage for 5-7days. A ventriculo-peritoneal shunt was performed in those who had persistent hydrocephalus after a week of spinal drainage.

Outcome Evaluation

Evaluation at 6 months after SAH was performed using the Glasgow Outcome Scale (GOS)[3]. The definition of GOS is shown in Table 2. Operative outcome was defined as the patient's outcome, based on GOS, at 6-month visit. Patients with a good recovery (GOS 1) or moderate disability (GOS 2) were classified as favorable outcome because they could live independently with a normal life. Patients with severe disability (GOS 3) or a vegetative state (GOS 4) were classified as unfavorable outcome because they could not live independently and needed support from their family.

Table 2. Definition of categories of the Glasgow Outcome Scale.[3]

Outcome category	Definition
GOS 1: Good recovery	Patient able to return to former occupation though not necessarily at the same level. May have minor neurological or psychological impairments.
GOS 2: Moderate disability	Patient unable to return to work, but otherwise able to perform the activities of daily living independently.
GOS 3: Severe disability	Patient requires assistance to perform daily activities and cannot live independently
GOS 4: Persistent vegetative state	Absence of speech or evidence of mental function in a patient who appears awake
GOS 5: Death	

RESULTS

Clinical Data

There were 62 patients in this study which included 21 males and 41 females. Mean age was 54.26 years (ranges 21 – 87 years). Clinical grade on admission is shown in Table 3. The location of aneurysm is summarized in Table 4.

Thirty two patients (53.2%) were admitted within the first 72 hours after SAH, 16.1% were admitted between day 4 and day 6 after SAH, and 30.6% were admitted at a later date.

Table 3. Clinical grade (of Hunt and Hess scale) on admission of 62 patients.

Clinical grade	Number of patient (%)
1	5 (8.1%)
2	12 (19.4%)
3	37 (59.7%)
4	7 (11.3%)
5	1 (1.6%)

Table 4. Location of the aneurysm.

Location of aneurysm	Number of patient (%)
Anterior communicating artery aneurysm	34 (54.8%)
Posterior communicating artery aneurysm	16 (25.8%)
Middle cerebral artery aneurysm	8 (12.9%)
Ophthalmic artery aneurysm	2 (3.2%)
Internal carotid bifurcation aneurysm	1 (1.6%)
Pericallosal artery aneurysm	1 (1.6%)

Surgery and Surgical Findings

Surgery was carried out as soon as possible after admission. Timing for surgery was divided into 3 groups : early, intermediate and late surgery. Early surgery (within 72 hours of SAH) was performed in 22 individuals (35.5%), intermediate surgery (day 4 – 6 following SAH) in 12 individuals (19.4%) and late surgery (day 7 and later following SAH) in 28 patients (45.1%).

There was no significant cerebral swelling found at operation except one case in which severe cerebral swelling was encountered because of intraoperative premature rupture of an aneurysm.

Surgical Outcome

At follow-up examination, there were 55 patients (88.7%) with a favorable outcome, 1 patient (1.6%) with an unfavorable outcome and 6 patients (9.7%) died. Details of surgical outcome are shown in Table 5. Cause of death is described in Table 6. Correlation between clinical grade on admission and surgical outcome is illustrated in Table 7. Surgical outcome in relation to timing of surgery is shown in Table 8.

Table 5. Detail of surgical outcome according to GOS.

Surgical outcome (GOS)	Number of patient (%)
GOS 1: Good recovery	49 (79%)
GOS 2: Moderate disability	6 (9.7%)
GOS 3: Severe disability	1 (1.6%)
GOS 4: Persistent vegetative state	0
GOS 5: Death	6 (9.7%)

Table 6. Cause of death of those dying postoperatively.

Patient	Cause of death (Day of mortality after operation)
1: P-com	Intraoperative premature rupture of aneurysm with severe brain swelling (Day 3)
2: A-com	Aspiration pneumonia with septic shock (Day 23)
3: MCA	Severe grade (grade 5) with sepsis (Day 83)
4: A-com	Incomplete clipping with rebleeding (Day 9)
5: A-com	Severe vasospasm with cerebral infarction (Day 90)
6: A-com	Incomplete clipping with rebleeding (Day 6)

Table 7. The correlation between clinical grade and operative outcome.

Clinical grade (No. of patient)	Operative outcome No. of patient (%)				
	GOS 1	GOS 2	GOS 3	GOS 4	GOS 5
1 (5)	5 (100%)	-	-	-	-
2 (12)	11 (91.7%)	1 (8.3%)	-	-	-
3 (37)	29 (78.4%)	3 (8.1%)	-	-	5 (13.5%)
4 (7)	4 (57.1%)	2 (28.6%)	1 (14.3%)	-	-
5 (1)	-	-	-	-	1 (100%)
Total 62 patients	49 (79%)	6 (7.9%)	1 (1.6%)	-	6 (9.7%)

Table 8. Correlation between operative outcome and timing of surgery.

Timing of surgery	No. of patient	Operative outcome				
		GOS 1	GOS 2	GOS 3	GOS 4	GOS 5
Early surgery	22	18 (81.8%)	1 (4.5%)	-	-	3 (13.6%)
Intermediate surgery	12	8 (66.7%)	2 (16.7%)	-	-	2 (16.7%)
Late surgery	28	23 (82.1%)	3 (10.7%)	1 (3.6%)	-	1 (3.6%)

DISCUSSION

After operation for intracranial aneurysms was developed in the 1960s and 1970s, many neurosurgeons achieved progressively lower postoperative mortality rates due to advances in microsurgical technique and general progress in radiology, anesthesia, and intensive care. Among these workers are Yasargil of Zurich and Drake of London, Ontario, who have established benchmarks of excellence in huge series of aneurysms in the anterior and posterior circulations respectively.[4,5] A step forward in understanding the course of this disease came with the introduction by Botterell, Hunt and Hess of a neurological grading system.[1,2] During the past two decades, the introduction of a calcium channel blocker (Nimodipine) and early surgery have significantly changed the therapy available for ruptured aneurysms by reducing the incidence of preoperative rebleeding and increasing the percentage of patients with complete recovery and social reintegration. However, management results and even operative outcome are affected mainly by the time of admission, the degree of patient selection for admission, and surgery and timing of surgery.[6-8]

Timing of surgery and Operative Outcome

Based on the management protocol for this disease in the Division of Neurosurgery, Siriraj Hospital in which the surgical repair of aneurysm is carried out as early as possible, however, early surgery (within 72 hours after SAH) was achieved in only 35.5% of patients. The causes of delayed operation were: 1) delay in the diagnosis of SAH which occurred at other hospitals or at Siriraj Hospital, 2) delay in referral to Siriraj Hospital, and 3) delays in the investigation process.

The present study showed that late surgery resulted in a better operative outcome than early surgery while intermediate surgery resulted in a worst outcome. Many reports showed the same results in which late surgery resulted in an excellent operative outcome, however, late surgery was also associated with significant mortality and morbidity from rebleeding and vasospasm occurring during the waiting period.[9-15]

Early surgery is closely related to difficult operative conditions and intra- or post-operative disasters. However, if surgery is delayed for a week or longer after SAH, the brain can recover from the acute effects of hemorrhage and the patient's conditions become stable. This is the reason why late surgery results in a better operative outcome than early surgery.[8] On the other hand, the only true measure is patient's outcome; this measure is referred to as "management outcome". Most reports showed that early surgery resulted in more favorable management outcome, by eliminating rebleeding and facilitating the management of vasospasm.[10,16-21]

Intermediate surgery (between day 4 and day 6 after SAH) showed the worst result.[7] During this period, the acute effects of hemorrhage remain and vasospasm occurs. Surgery undertaken during the evolution of vasospasm carries a higher risk of ischemic neurological deficit.[1]

Patient's Clinical Grade and Outcome

The present study showed that the patient's clinical grade on admission was related to operative outcome. The lower the patient's clinical grade the higher the proportion with a favorable outcome (GOS 1 and 2). A higher clinical grade results in the higher operative mortality rate.

In a cooperative study on the timing of aneurysm surgery involving 3,521 patients, the most important factors predicting outcome were the level of consciousness which contributed to both death and disability, and the presence of hemiparesis and/or aphasia which was important in relation to disability but had no effect on mortality.[22]

Overall Operative Outcome

Of 62 patients, favorable outcome (GOS 1 and 2) was achieved in 55 patients (88.7%), unfavorable outcome (GOS 4 and 5) in 1 patient (1.6%) in which his postoperative state was severe disability which was the same as his preoperative state. The operative mortality rate was 9.7% (6 patients). Causes of death were surgically related complications in 3 patients (4.8%) and non-surgically related complications (ischemic complication and sepsis) in other 3 patients (4.8%).

The operative outcome is affected mainly by the degree of patient selection for admission, clinical grade of patient on admission, and timing of surgery. Yasargil, Suzuki et al., and Sundt reported large series with low operative mortality rates. The mortality rates of these series were 4%, 5% and 6% respectively.[4,18,23] The explanation in part of the low overall mortality rate in these series lies in the delay in transfer to, natural selection that occurred prior to arrival at major tertiary referral centers, and the delay in operation after SAH.[1] Although the patients in these large series were operated on as early as possible, only 17% to 18% of patients were operated before day 7 following SAH.

In various individual studies of operative outcome, the percentage of patients with good outcome ranged from 41% to 85.2% and operative mortality rate ranged from 5% to 23%.[6,8,22,24-30] However, the definition of good outcome and operative mortality rate among these series varied. To compare each individual study to the others, detail of measurement should be carefully considered.

The present study showed a comparable outcome to other published studies, however, the only true measure is management outcome which requires a more sophisticated study and a larger patient population.

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