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Surgery of Intracranial Aneurysms : Experience of 100 Cases

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Abstract

Objective: **The purpose of this study was to evaluate the results of surgical treatment in 100 cases of intracranial aneurysms performed by the author.**

Materials and Methods: **The study was designed as a retrospective study involving 100 patients (57 females and 43 males) who underwent surgery for ruptured intracranial aneurysm between 1991-2002. Patients' age, gender, location of aneurysm, and subarachnoid hemorrhage (SAH) clinical grading (Hunt and Hess grading) were studied and correlated with the outcome following surgery.**

Results: **Thirty six patients (36%) had aneurysm of the posterior communicating artery (PcoA), 33 patients (33%) had aneurysm of the anterior communicating artery (AcoA) and 17 patients (17%) had aneurysm of the middle cerebral artery (MCA). The outcome as evaluated by the Glasgow outcome scale was good recovery in 60 patients (60%), moderate disability in 11 patients (11%), severe disability in 7 patients (7%) and death in 22 patients (22%). Good recovery and moderate disability patients (71 patients or 71%) were classified under the favorable outcome group whereas patients with severe disability and death (29 patients or 29%) were classified under the unfavorable outcome group. According to Hunt and Hess SAH grading, the patients with SAH grade I-III had favorable outcome in 60 patients (92%) and unfavorable outcome in 5 patients (8%) whereas the patients with SAH grade IV-V had favorable outcome in 11 patients (31%) and unfavorable outcome in 24 patients (69%).**

Conclusion: **This study of 100 cases revealed 71 cases with favorable outcome, 7 cases with severe disability and 22 death cases. Patients with SAH grade I-III had favorable outcome in 60 cases (92%) and death in 5 cases (8%). Factors that affected the outcome were SAH clinical grading and the age of patients.**

The result of surgical treatment of intracranial aneurysms was first reported by Dott[1] in 1933. In accordance with several reports, the favorable outcome was due to the continuously developing microsurgical technique since 1960, the advance technique of radiology, microsurgery and patient care.[2-9] The death and disability of those patients were caused by the severity of subarachnoid hemorrhage and subsequent delayed vasospasm. The treatment that effectively reduced such severity was Triple H Therapy (Hypertensive Hypervolemic Hemodilution).[10,11] Early surgery after surviving from the first episode of aneurysm

Table 1 Pre-operative clinical grading by Hunt and Hess grading

SAH* Grade	Description
I	Asymptomatic or minimal headache and slight nuchal rigidity
II	Moderate to severe headache, nuchal rigidity, no neurological deficit other than cranial nerve deficit
III	Drowsiness, confusion, or mild focal deficit
IV	Stupor, moderate to severe hemiparesis, possible early decerebrate rigidity
V	Coma or moribund appearance

**SAH = Subarachnoid Hemorrhage*

Table 2 Results of treatment evaluated by Glasgow Outcome Scale

GOS*	Description
1. Death	
2. Persistent vegetative state	Absence of function in cerebral cortex
3. Severe disability (SD)	Dependent on daily support
4. Moderate disability (MD)	Independent and able to work in a sheltered environment
5. Good recovery (GR)	Resumption of normal life even though with minor deficit

**GOS = Glasgow Outcome Scale*

rupture did not only prevent rebleeding of aneurysm but also provided aggresssive treatment of delayed vasospasm.[12-15]

The objective of this study was to evaluate the results of surgical treatment of 100 cases of intracranial aneurysms performed by the author.

Materials and Methods

This study was designed as a retrospective study involving 100 patients who underwent surgery for ruptured intracranial aneurysm during 1991-2002. The patient's gender, age, pre-operative clinical symptom grading by Hunt and Hess grading[16] (Table 1), location of aneurysm, type of operation, complications and results of treatment after the follow up of not less than 6 months were studied and evaluated by Glasgow Outcome Scale[17] (Table 2).

Good recovery and moderate disability patients were classified under the favorable outcome group whereas patients with severe disability and death were classified under the unfavorable outcome group.

Results

The authors studied 100 patients, classified by gender and age as detailed in Table 3. The proportion of females to males was approximately 4:3. It was noticeable that in 33 cases of the group under 51 years of age, the ratio between female and male was 1:2; whereas the group above 50 years of age, the ratio was approximately 2:1. Most patients were found in 51-60 years of age whereby the youngest was 28 years and the oldest was 81 years. The locations of aneurysm are shown in Table 4.

Table 3 Numbers of patients classified by gender and age

Age	Female	Male	Total
21 - 30	0	3	3
31 - 40	3	7	10
41 - 50	8	12	20
51 - 60	26	16	42
61 - 70	10	3	13
71 - 80	9	2	11
81 - 90	1	0	1
Total	**57**	**43**	**100**

Table 4 Locations of aneurysm

Locations	No. of Case
Posterior Communicating Artery (PcoA)	36
Anterior Communicating Artery (AcoA)	33
Middle Cerebral Artery (MCA)	17
Distal Anterior Cerebral Artery (ACA)	3
Basilar Artery (BA)	2
Posterior Inferior Cerebellar Artery (PICA)	3
Superior Hypophyseal Artery	2
Anterior Chloroidal Artery	2
Intracavernous Internal Carotid Artery (ICA)	1
Vertebral Artery (VA)	1

Aneurysms were found in multiple sites in 6 patients whereby in 3 cases aneurysms were found at both sides of PCoA and 2 cases were found at both sides of MCA and 1 case each was found at PCoA and MCA.

The data comparing correlation between age and SAH grade are shown in Table 5. In 75 cases of patients

Table 5 Correlation between age and SAH Grading

Age	SAH Grades No. (%)					Total
	I	II	III	IV	V	
21 - 30	2 (67)	1 (33)	0	0	0	3
31 - 40	3 (30)	5 (50)	1 (10)	1 (10)	0	10
41 - 50	5 (25)	8 (40)	4 (20)	3 (15)	0	20
51 - 60	4 (10)	17 (40)	6 (14)	13 (31)	2 (5)	42
61 - 70	1 (8)	3 (23)	1 (8)	7 (53)	1 (8)	13
71 - 80	1 (9)	2 (18)	1 (9)	7 (64)	0	11
81 - 90	0	0	0	1	0	1
Total	**16**	**36**	**13**	**32**	**3**	**100**

Table 6 Procedure and approach

Procedure and Approach	No.
Pterional	44
Supra-orbit pterional	46
Transcavernous	3
Suboccipital	4
Ventricular drainage	2
Ventriculo - peritoneal shunt	8
Frontal interhemispheric	3
Complete clipping	95
Incomplete clipping	2
Trapping	2

Table 7 Complications and causes of death

Complications	No.	Death cases
Delayed ischemic deficit	18	7
Brain infarction	5	5
Massive SAH	-	5
Hydrocephalus	8	-
Septic shock	2	2
Pneumonia	1	-
Preoperative rebleeding	1	1
Uncal brain herniation	1	-
Optic nerve injury	1	-
Fulminant hepatitis	1	1
Premature Rupture	1	1

under 61 years of age, 4 cases (18%) were of grade I, 31 cases (41%) grade II, 11 cases (15%) grade III, 17 cases (23%) grade IV, and 2 cases (3%) grade V. But in 25 cases of patients above 60 years of age, 2 cases (8%) were of grade I, 5 cases (20%) grade II, 2 cases (8%) grade III, 15 cases (60%) grade IV, and 1 case (4%) grade V.

There were 11 cases that were not diagnosed as SAH when first admitted to the hospital. These were 3 cases of head injury, 3 cases of headache by unknown cause, 1 case of tension headache, 2 cases of basal ganglion hemorrhage and 2 cases showed no abnormality by angiogram. There was one case that SAH was not diagnosed and subsequent rebleeding resulted in poor outcome.

Surgical methods were shown in Table 6. In the early period, aneurysm at anterior circle of Willis was based on the pterional approach[2,3,18] but the supra-orbital pterional approach,[19,20] a skull base approach technique, was used subsequently. This latter approach minimized brain retraction and did not require spinal drainage or diuretic infusion.

A serious complication during surgery was intraoperative rupture.[21-23] Such incidents happened in 11 cases. Five cases of rupture occurred during aneurysm dissection, and another 5 cases during clip applying to the aneurysm neck. Bleeding control and clipping were successful in all cases that prior to this step, proximal and distal control were well established. In the remaining one case intraoperative rupture occurred before proximal and distal control could be achieved (premature or predissection rupture) led to failure of aneurysm clipping. Nevertheless this patient was in SAH grade IV and had a large intra-cerebral hematoma.

Postoperative complications and death (Table 7) were mostly caused by delayed ischemic deficit following vasospasm from SAH.

The comparative outcome with SAH grading is shown in Table 8. Of 65 cases with SAH grades I, II and

Table 8 Correlation between SAH grade and outcome

SAH Grade	Outcome No. (%)				Total
	GR	MD	SD	D	
I	16 (100)	0	0	0	16
II	28 (78)	5 (14)	0	3 (8)	36
III	11 (85)	0	0	2 (15)	13
IV	5 (16)	6 (19)	6 (19)	15 (47)	32
V	0	0	1 (33)	2 (67)	3
Total	**60**	**11**	**7**	**22**	**100**

Table 9 Correlation between age and outcome

Age	Outcome No. (%)				Total
	GR	MD	SD	D	
21 - 30	3 (100)	0	0	0	3
31 - 40	8 (80)	1 (10)	1 (10)	0	10
41 - 50	18 (90)	1 (5)	0	1 (5)	20
51 - 60	24 (57)	5 (12)	4 (10)	9 (21)	42
61 - 70	5 (38)	1 (8)	1 (8)	6 (46)	13
71 - 80	2 (18)	3 (27)	0	6 (55)	11
81 - 90	0	0	1 (100)	0	1
Total	**60**	**11**	**7**	**22**	**100**

Table 10 Correlation between site of aneurysm and outcome

Sites	Outcome No. (%)				Total
	GR	MD	SD	D	
Posterior Communicating Artery (PcoA)	19 (53)	5 (14)	2 (5)	10 (28)	36
Anterior Communicating Artery (AcoA)	20 (60)	2 (6)	3 (10)	8 (24)	33
Middle Cerebral Artery (MCA)	9 (53)	3 (17)	2 (12)	3 (18)	17
Intracavernous Internal Carotid Artery (ICA)	5	-	-	-	5
Distal Anterior Cerebral Artery (ACA)	3	-	-	-	3
Posterior Inferior Cerebellar Artery (PICA)	3	-	-	-	3
Vertebral Artery (VA)	-	1	-	-	1
Basilar Artery (BA)	1	-	-	1	2
					100

III, favorable outcomes, namely good recovery (GR) and moderate disability (MD), were found in 60 cases (92%) with 5 deaths (8%). Of 35 cases with SAH grades IV and V, 11 cases (31%) had favorable outcome, 7 cases (20%) had severe disability (SD) with 17 deaths (49%).

The outcome with respect to the age of patients (Table 9) showed that in 75 cases where patients were under 61 years, favorable outcome was found in 60 cases (80%), SD in 5 cases (7%) and death in 10 cases (13%). For the 25 cases above 60 years of age, favorable outcome was found in 11 cases (44%), SD in 2 cases (8%) and death in 12 cases (48%)

The outcome compared with the location of aneurysm is shown in Table 10. Aneurysms were frequently found at 3 locations namely, ACoA (33 cases), PCoA (36 cases), and MCA (17 cases). Twenty-two cases (67%) of aneurysm at ACoA had favorable outcome and 11 cases (33%) had unfavorable outcome (SD and Death). Twenty-four cases (67%) of aneurysm

at PCoA had favorable outcome and 12 cases (33%) unfavorable outcome. Eighteen cases (70%) of aneurysm at MCA had favorable outcome and 5 cases (30%) unfavorable outcome.

Discussion

Results of this study based on gender and age were not different from other reports.[24] It was found that there were more female patients than male patients (4:3) but males were found more than females in patients under 51 years of age (3:2) while females were more than males in patients older than 50 years (2:1).

In view of aneurysm location, the common locations were at ACoA, PCoA, and MCA (86%) previous reports.[24-26] However, ACoA was the most common location reported,[5] but PCoaA was most common in this study, being slightly more than ACoA.

Pre-operative rebleeding occurred in a SAH grade I patient with aneurysm at MCA, who had massive subdural hematoma on the night before scheduled operation. The patient was immediately operated upon but did not recover and died later on. The treatment up to present has therefore emphasized on the earliest operation as soon as the patient has been readily prepared.

Misdiagnosis affected the outcome in the case of rebleeding of aneurysm. The rate of death from aneurysm rupture was approximately 50 per cent.[25] One undiagnosed case died from massive SAH after one month history of severe headache and hypertension.

The important principles of operative technique include wide arachnoid dissection, minimal brain retraction, and proximal and distal control of the aneurysm.[2,3,8,18-20] The final step involves aneurysm dissection and clip applying at the neck of the aneurysm. The important element was the shape and location of the aneurysm, such as, aneurysm at the internal carotid artery (ICA), especially at PCoA, the wider neck and more atherosclerotic vessel. These may lead to increased risk and incomplete clipping. The most dangerous condition was in the case of a torn neck of aneurysm where clipping was impossible and required trapping (clipping proximal and distal to aneurysm).

The important post-operative complication mostly found was delayed vasospasm. Triple-H therapy[10,11] (hypertensive hypervolemic hemodilution) is now being continuously studied because there is no methods which provides a better outcome without any complications. In this study, the patient was kept in hypervolemic hemodilution based on the clinical symptom, blood chemistry and urine output until the patient recovered.

The overall results of treatment correlated to the SAH grade and age of the patient. It was noticeable that most complications and the main cause of death and disability was due to vasospasm complicated from SAH and its severe affect upon clinical symptom. The age of patients correlated to the SAH grade. In patients above 60 years of age, mostly were of SAH grade IV and V while mostly were of SAH grade II and III in those under 61 years of age, in line with other reports.[5-7]

In comparison with other reports,[5-7] it was found that in SAH grade I, II and III bore similar outcomes to that of this study. For example, Naso et al[5] reportd 90.5 per cent with favorable outcome and 7.1 per cent death, while this report showed 92 per cent favorable outcome with 8 per cent death. However, for patients in SAH grade I and V, the unfavorable outcome was higher than those reports which observed 45.5 per cent favorable outcomes with 36.4 per cent deaths while this report had 31.4 per cent favorable outcomes and 48.6 per cent deaths.

Comparing SAH in 3 common locations, namely, ACoA, PCoA and MCA, showed no difference in the treatment outcome.

Conclusion

This study of 100 cases revealed 71 cases to have a favorable outcome, 7 cases with severe disability, and 22 death cases. Patients with SAH grade I-III had favorable outcome in 60 cases (92%) and death in 5 cases (8%). Factors that affected outcome were SAH clinical grading and the age of patients.

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