

# Surgical Experiences for Intracranial Aneurysms (3,000 Cases)

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**Objective :** The present study evaluated overall surgical results for 3,000 patients with intracranial aneurysms, operated on in Busan Paik Hospital institution.

**Methods :** Three thousand aneurysm cases, operated on in Busan Paik Hospital between January 1980 to June, 15th, 2005, were evaluated based on the following criteria; aneurysm form, aneurysm location, surgical results, postoperative complications, and seasonality of occurrence. 957 cases were anterior communicating artery aneurysms, 776 were internal carotid artery(ICA) aneurysms, 755 were middle cerebral artery(MCA) aneurysms, 96 were anterior cerebral artery(ACA) aneurysms, 128 were vertebro-basilar artery(VBA) aneurysms and 288 were multiple aneurysms. The male to female ratio was 0.7 to 1. Surgical methods included 2,738 clippings, 219 coating and wrappings, 23 aneurysmorrhaphies, 20 proximal ligations.

**Results :** Rebleeding occurred in 5.1% of the early operation group and 16% of the late operation group respectively. Incidence of clinical vasospasm was 16.6% and angiographic vasospasm was 24.1%. The percentage of the multiple aneurysms was 9.5%, the percentage of the dissecting aneurysm was 6 cases (0.2%), 6 of the total (0.2%); "De Novo" aneurysm, the percentage of lobectomies with clipping cases was 9 cases (0.3%), the percentage were incidental aneurysms; 164 (5.5%). 88.1% had overall favorable surgical results with a 5.5% mortality rate. Calcium-channel blocker and "Triple H" therapy did not improve mortality but did significantly improve morbidity. In the old age group, early operation reduced vasospasm, rebleeding and medical complications. The early surgery group exhibited a 86.2% favorable outcome with a 8.1% mortality rate. Intraoperative angiography reduced residual or remained aneurysms in large, giant aneurysm, especially in A.com artery aneurysm.

**Conclusion :** The surgical results for the early surgery group according to surgical timing was better, but there were not statistically significant. Intraoperative angiography was especially useful on large aneurysms of the anterior communicating artery.

**KEY WORDS :** Aneurysm · Surgical methods · Rebleeding · Operation.

## Introduction

In aneurysmal subarachnoid hemorrhages, the patient's age, preoperative clinical condition, large intracerebral hematoma, hydrocephalus, the presence of the vasospasm, etc. were considered. Recently, improvements in the surgical technique, microsurgical and balloon angioplasty, the use of the transcranial doppler ultrasound, etc. have contributed to beneficial surgical results minimizing harm to surrounding brain tissue.

At Paik Hospital, early surgery reduced the mortality rate from rebleeding. Since 1982, the use of nimodipine and Triple H therapy significantly decreased the morbidity rate from clinical vasospasm.

We performed operations on 3,000 aneurysm cases and 107 endovascular treatment cases from 1980 to June, 15th, 2005. This report deals with the incidence of seasonal occurrence, classified location, the surgical results of the aneurysm, postoperative complications, incidence and management of multiple aneurysms, dissecting aneurysms, and incidental aneurysm.

## Materials and Methods

This study included 3,000 aneurysm operation cases in the Neurosurgical department, Inje University, Busan Paik Hospital from 1980 through June, 2005. Aneurysmal subarachnoid hemorrhages were diagnosed in 3,694 cases, although

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694 were not operated on. Reasons against operation in unoperated cases, were; refusal of operation, 294 cases; discharge due to major rebleeding, 152 cases; medical problems, 109 cases; discharge due to ischemic complication, 97 cases, within reasons undisclosed.

Aneurysm diagnosis was performed using computed tomography, cerebral angiography, magnetic resonance angiography, and computed tomography angiography. Cerebral angiography was done immediately after admission, and was performed twice in 27 cases, three times in 2 cases. MRA was only used in 15 cases, CT angiography in only 20 cases, no angiography was done for 34 middle cerebral artery aneurysms with large intracerebral hematomas.

In all cases, intraoperative video recording through a surgical microscope, and photographs of the operative field, were used while postoperative recording and drawings were also performed. In complex artery aneurysms, an intraoperative angiography was used. If postoperative clinical condition showed no improvement, a postoperative angiography was performed. Annual, seasonal and monthly occurrence of surgical results according to surgical timing, postoperative complications, unusual aneurysms, were also analysed via clinical chart and operative recording.

## Results

### Annual incidence of operated aneurysm

In 1980, 9 cases were operated on. In 1989 the number of aneurysm operations exceeded 100 for the first time, 158 cases in 1995, 179 cases in 1997, 163 cases in 1998, 181 cases in 1999, 184 cases in 2000, 179 cases in 2004, and until 15th June, 2005, 88 cases. Thus, over the study period there has been a gradual increase the annual incidence of aneurysm(Fig. 1).

### Seasonal and monthly incidence

Of the 3000 aneurysm, 806 cases(27%) occurred in spring (March, April, May), in summer( June, July, August), 700 cases

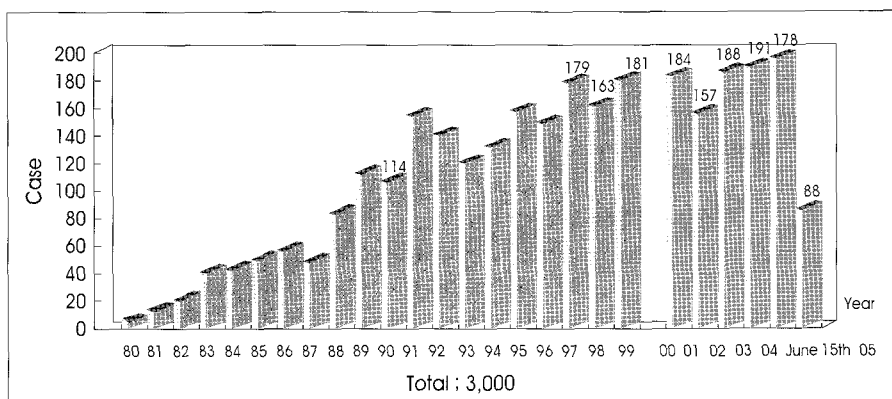


Fig. 1. Annually operated aneurysm.

Table 1. Sex and Age Distribution

Age/Sex	Male	Female	Total
10 month - 20	13	10	23
21 - 30	59	43	102
31 - 40	213	162	375
41 - 50	438	430	868
51 - 60	297	526	823
61 - 70	141	470	611
71 - 88	31	167	198
Total	1,192	1,808	3,000

Table 2. Location of aneurysm

Location	No. of cases
A. Com A.	957(31.9%)
ICA	776(25.9%)
MCA	755(25.2%)
Vertebro-Basilar	128(4.3%)
Multiple	288(9.5%)
ACA	96(3.2%)
Total	3,000(100%)

\* abbreviations ; A. Com A. ; anterior communicating a., ICA ; internal carotid a., MCA ; middle cerebral a., ACA ; anterior cerebral a.

(23.3%); autumn (September, October, November), 700 cases (23.3%); and in winter (December, January, February), 794 cases (26.5%). Therefore; no seasonal difference was identified in the study group.

### Sex and age distribution

Over half of the patients were in their fifties and sixties, with 868 patients in their fifties, and 823 in their sixties. 23 cases involved patients less than 20 years old, 198 patients over 70 years old. The female to male ratio was 1:0.7. The incidence in females was higher. Table 1 shows the ratio incidence to age with males less than 50 and females over 50 both exhibiting a greater incidence of aneurysms.

### Location and size of aneurysm

Aneurysm location is summarized in Table 2. In this series, aneurysms were identified at the following locations; 957 (31.9%) at the A. com A's, 776 (25.9%) at the ICA's, 755 (25.2%) at MCA's, 288 (9.5%) at the multiple, 128 (4.3%) at the vertebro-basilar arteries (Table 2).

Of the 3,000 aneurysms; 72% or 2,185 were small (<10mm), 26% or 763 cases were large (10~25mm) with 2%, 52 cases were giant (>25mm).

### Multiple Aneurysms

288 cases (9.6%) possessed more than one aneurysm. Of these 288 cases, 174 cases (60.4%) were at the

ipsilateral site, 114 cases (39.6%) were at the contralateral site. Ipsilateral aneurysm locations were; 43 cases (14.9%) at ipsilateral ICA and MCAs, 41 cases (14.2%) at ipsilateral A.com A. and MCAs, 30 cases (10.4%) at ipsilateral ICA and contralateral ICAs.

**Dissecting aneurysms**

15 cases possessed dissecting aneurysms, and all arose from vertebro-basilar arteries. Surgical intervention was performed in 6 of the cases.

**“De Novo” aneurysm**

6 cases (0.2%) were “De Novo” aneurysm. Table 3 shows the summaries of “De Novo” aneurysms. Case 1 showed an early rupture “De Novo” aneurysm after clipping of the anterior choroidal artery aneurysm after 1 month in a 35-year-male patient (Table 3).

**Incidental aneurysm**

The percentage of the incidental aneurysm was 5.5% (or 164 cases). The locations for the incidental aneurysm were; 58 cases at MCAs, 48 cases at ICAs, 32 cases at A. com. As, and 7 cases at posterior circulation aneurysm.

**Surgical approaches and methods**

Surgical approaches to the anterior circulating aneurysms were mainly pterional, while subtemporal and orbitozygomatic approaches were preferred in basilar artery aneurysms. The sub-occipital approach was preferred in PICA and vertebral artery aneurysms, and a combined transpetrosal approach was used for AICAs, etc.

Surgical methods included; clipping 2,738 (91.3%), coating and wrappings 219, proximal ligations 20 (0.7%), aneurysmor-

**Table 3.** “De Novo” Aneurysm(6 cases)

Case No.	Location of the aneurysm	Interval
1	Lt. Ant. choroidal a. aneurysm → 1) Lt. A2 aneurysm 2) A1-A2 junction aneurysm	1 month
2	Lt. MCA Aneurysm → Lt. P. com a. Aneurysm	10 years
3	Basilar tip Aneurysm → Lt. P. com a. Aneurysm	3 years
4	A. com a. Aneurysm → Rt. P. com a. Aneurysm	11 years
5	Distal ACA Aneurysm → A1-A2 Junction Aneurysm	9 years
6	A1-A2 Junction Aneurysm → Ant. choroidal a. Aneurysm	15 years

**Table 4.** Operation Method

Clipping	2,738( 91.3%)
Coating & Wrapping	219( 7.3%)
Aneurysmorraphy	23( 0.8%)
Proximal ligation	20( 0.8%)
Total	3,000(100%)

\* Excluded Endovascular treatment 107

raphys 23 (0.8%). This excluded 107 endovascular treatment cases (Table 4).

**Rebleeding and vasospasm**

Rebleeding occurred in 5.1% of the early operation group, in 16% of the late operation group. Clinical vasospasm occurred in 16.6%, and angiographic vasospasm in 24.1%.

**Incidence of vasospasm after use of Nimodipine and Triple H therapy**

Before October 1988, vasospasm occurred in 35% of the patients. Nimodipine and Triple H therapy was used from October, 1988 and 368 cases (14.0%) of 2,632 cases showed delayed ischemic deficits resulting from vasospasm.

**The use of the temporal clip and the tentative clip**

During operational procedures the use of the temporal clip could facilitate diminished risk of premature rupture. Occasionally, it was possible to use a tentative clip. In these cases, the tentative clip was useful in preventing blood flow interruption.

**Surgical results**

Results were determined at discharge or during the follow-up examination.

The patients were divided into four groups, good, fair, poor, dead. Patients who had no neurological deficits and had returned to full activity were considered to fall into the “good” category. Patients who were at home and self-capable but who had a persistent neurological deficit or memory disturbances, were classed as having a “fair result”. Severely disabled patients, totally dependent on others, were classed as having a “poor result”.

Overall surgical results for the subjects, with 48.7%, and 40% in the excellent and good categories respectively. Thus favorable result were obtained for 88.7% of all subject; however there was a 5.5% mortality rate for all subjects. Of 1,380 subjects operated on within three days after admission, 730 cases (53%) showed excellent results; 527(39%) good results; and 438 cases (4%) dead. Of 960 cases were operated on between 4-10 days after admission 63 (46%) had excellent results; 363 cases (37.8%) good results; 74 cases (7.8%) were dead. For those 660 subjects operated on 10 days after admission, 292 cases(44.2%) had excellent results; 281 (42.6%) had good results, and 43 (7%)

**Table 5.** Overall operative results

Surgical Timing	Outcome				Total(%)
	E*	G*	P*	D*	
0 - 3	582(51)	446(39)	61(5)	59(5)	1,148(100)
4 - 10	357(46)	303(39)	62(8)	56(7)	778(100)
10 <	264(46)	230(40)	37(7)	43(7)	574(100)
	1,406(48.7%)	1,171(39.4)	192(6.4)	177(5.5)	3,000(100)

\* E : Excellent \* G : Good \* P : Poor \* D : Dead

died. Table 5 shows there was no statistical difference according to surgical timing.

Surgical results according to surgical timing were classified using Hunt and Hess classifications I-V. 1,380 cases (46.0%) were operated on within 3 days of admission. In 330 (24%) cases classified as Hunt-Hess grade I, 323 cases(97.8%) had a favorable outcome and 4 cases(1.5%) died. In 567(42%) cases Hunt-Hess grade II, 552(97.4%) cases had a favorable outcome, while 6(1.1%) cases died. In 234(17%) cases identified as Hunt-Hess grade III, 208(88.9%) cases showed a favorable outcome, while 12(5.1%) cases were classified as dead. In 221 (16%) cases classed as Hunt-Hess grade IV, 165(74.7%) cases had a favorable outcome, and 26(11.8%) cases died. In 28(2%) cases classified as Hunt-Hess grade V, 9(32.1%) cases, had a favorable outcome, while 19(67.9%) cases died.

960(32%) cases were operated on 4-10 days after rupturing. In 164(17.1%) cases classed as Hunt-Hess grade I, 148(90.2%) cases had a favorable outcome, and 4(2.4%) cases died. In 357 (37.2%) cases classified as Hunt-Hess grade II, 318(89.1%) cases had a favorable outcome, 14(3.9%) cases died. In the 314 (32.7%) cases identified as Hunt-Hess grade III, 277(88.2%) cases had a favorable outcome, while 23(7.3%) cases died. In the 96(10%) cases categorized as Hunt-Hess grade IV, 58(60.4%) cases had a favorable outcome, and 16(16.7%) cases died. Lastly, in 29(3%) cases classed as Hunt-Hess grade V, 12(41.4%) cases died.

Of the 660(22%) cases operated on 10 days after rupturing. Of 158(23.9%) cases identified as Hunt-Hess grade I, 151 (95.6%) cases had a favorable outcome, and 3(1.2%) cases died. For the 253 cases categorized as Hunt-Hess grade II, 237 (93.7%) cases had a favorable outcome, while 8(3.2%) cases died. For 158(23.9%) cases identified as Hunt-Hess grade III, 137(86.7%) cases had a favorable outcome, and of 91(13.9%) cases grouped as Hunt-Hess grade IV, 48 (52.7%) cases had a favorable outcome, while 19(20.9%) cases of those died. Surgical results were favorable if preoperative conditions were good and there was no statistical difference in surgical timing.

In the old age group (> or equal 65 years), 176 cases were operated on within 24 hours. 152(86.2%) cases exhibited favorable outcome and 14(8.1%) cases died. In the cases operated on between 2 days to 4 days, 42(8.5%) cases exhibited favorable outcomes and 5(7.4%) cases died. In the delayed operation after 4 days group, 56(71.1%) cases exhibited favorable outcomes and 8(10.6%) cases died.

#### Reclipping of the aneurysm with intraoperative angiography

7 patients among 72 cases underwent intraoperative angiography had the reclipping operation due to residual aneurysm or incomplete clipping.

#### Reoperation of the aneurysm

33 cases had their aneurysms reoperated on. The sites of the aneurysms were the anterior communicating artery(17), the internal carotid artery(8), and basilar tip(6). The causes for the reoperation were; residual neck 9, ; vessel occlusion 8, ; rebleeding after coating 5, ; aneurysm filling 3.

#### Lobectomy with clipping

In 9 (0.3%) cases, intraoperative aneurysmal rupture occurred, and lobectomy and aneurysm clipping were applied. The aneurysms locations were; the internal carotid artery 7, posterior inferior cerebellar artery 1; A com A 1 ; with 3 cases surviving.

#### Direction of fundus in A. Com. a. aneurysm

There were 957 cases anterior communicating artery aneurysm.

The anterior projection occurred in 220(23.0%) cases, the superior projection in 182(19.0%) cases, the posterior projection in 110(11.5%) cases, an inferior projection in 257(26.9%) cases, and complex projection in 188(19.6%) cases.

#### Postoperative complications

In 281(9.36%) cases ischemic complications due to vasospasm was most common, 256(8.5%) cases had medical complications such as; electrolyte imbalance, pneumonia, sepsis, deep vein thrombosis, aggravation of preexisting medical disease, and 50 cases had intracranial hematoma, 48(1.6%) cases contracted infection such as meningitis or wound infection. There were 141(4.7%) cases of hydrocephalus, 25(0.8%) cases of rebleeding due to incomplete clipping of the aneurysm or another aneurysmal rupture, and 41(1.4%) cases exhibited visual disturbance. In the early surgery group, within 3 days, 95(3.2%) cases had ischemic complications, and 61(2.0%) cases had medical complications as compared to the late surgery group. In the surgery group after 10 days, 74(2.5%) cases had ischemic complications, while 103(3.5%) cases had medical complications.

Locations of the developing hydrocephalus were 58(41.0%) cases for the anterior communicating artery's, 42(29.9%) cases for the internal carotid artery's, 23(16.2%) cases for the middle cerebral artery's, and 9(6.8%) cases for the vertebro-basilar artery's.

## Discussion

The rate of the aneurysmal subarachnoid hemorrhage occurs in approximately 8.25 per 100,000 annually<sup>17)</sup>. Early detection is possible before the rupture of the aneurysm owing to computed tomography angiography, advanced diagnostic instrument, etc.

Common locations for the aneurysm were; the internal caro-

tid artery, the middle cerebral artery, etc. Kassell, et al.<sup>4)</sup> reported 39% were located in the ACAs, 30% in the ICAs, and 22% in the MCAs, and 8% in the vertebrobasilar artery. Stehbens, et al.<sup>19)</sup> reported that 32.3% were located in the AcomAs, 27.2% in the ICAs, and 25.4% in the MCAs. Common ages ranged from fifties to seventies. Below sixties, males showed a preponderance in occurrence, while, above sixty, females showed a preponderance<sup>4,19)</sup>. In our study, 54.4% were between sixty to eighty, showing male preponderance below fifty, female preponderance above sixty. Regarding aneurysm size, Sahs et al.<sup>15)</sup>, reported 60% were small aneurysms from 3mm to 10mm, 35% were large aneurysms, 3% were giant aneurysms, and 2% were less than 3mm. In our study, 72% were small aneurysms, 26% were large aneurysms, and 2.0% were giant aneurysm. With respect to surgical methods, Kassell et al.<sup>4)</sup> reported that 94% had clipping, 2% had wrapping, and 1% had coating among a study of 3,521 cases. Comparatively, Lee et al.<sup>6)</sup> reported that 93.4% had clipping, 4.6% had coating and wrapping among 1,000 cases. In our study, 2,738(91.3%) cases had clipping, 219(7.3%) cases had coating and wrapping. In 23(0.8%) cases of aneurysmorrhaphy, 20(0.8%) cases had the proximal ligation performed among 3,000 cases excluding 107 cases of endovascular treatment. Kassell, et al.<sup>1,5)</sup> reported the incidence of the rebleeding was 4.1% within first 24 hours, and 19% within first 2 weeks in the Cooperative aneurysm Study. Yoshimoto, et al.<sup>24)</sup>, reported 24% rebleeding. In our study, 5.1% of rebleeding occurred in the early surgery group, 16% in the late surgery group. Kassel et al.<sup>4)</sup> comparatively reported occurrence of angiographic vasospasm incidence at 30~70 percent, with symptomatic vasospasm occurring in 20~30 percent of patients. In our study, 16.6% exhibited clinical vasospasm, while 24.1% showed angiographic vasospasm.

In the vasospasm study using nimodipine, the incidence of vasospasm ranged from 1.7~16% with nimodipine, and 13.3~37% with the group using a placebo<sup>2,3,12,13)</sup>. In our study, surgery prior to October 1988 reported the incidence of the vasospasms at 35%, while the incidence of vasospasm decreased to 14.0% after using nimodipine following October 1988. Beginning in 1982, early aneurysm surgery was initiated. Currently, early aneurysm surgery is primarily performed.

While ultraearly surgery is used in cases exhibiting presence of hydrocephalus, large hematoma, and intraventricular hemorrhage on old age ( $\geq 65$  years). Delayed operation was performed on poor grade aneurysms; vasospasm verified by transcranial doppler with the velocity of the middle cerebral artery being  $\geq 140$ cm/sec, blood flow  $\leq 30$ ml/100gm/min in 133Xe-CT, combined medical disease, transferred too late, and weekend admission<sup>18)</sup>. Intraoperative angiography was performed after clipping of the aneurysm in giant aneurysm cases, complex artery aneurysm, etc. The incidence of the "De Novo" aneur-

ysm is one per 1,000 aneurysms annually, it common occurs between thirty and forty year of age, and the interval is 3~20 years after operation<sup>8)</sup>.

Yasargil, et al.<sup>25)</sup>, reported 2.9% of the new aneurysms developed at perioperated site, and the contributory effects of smoking, oral contraceptive medication, and female sex hormones, and carotid ligation seem to be important<sup>24)</sup>.

In our study, 6(0.2%) cases of "De Novo" aneurysms developed. The early rupture "De Novo" aneurysm case occurred 1 month later, in two of the A2 portion aneurysms after clipping of the anterior choroidal artery aneurysm in a 35 year-old-male-patient. Another five cases of "De Novo" aneurysm developed after clipping of the aneurysm. The interval was between 3 and 15 years. Dissecting aneurysms developed among spontaneous subarachnoid hemorrhage<sup>9,10,16)</sup>, 3~7% of the time. The most common location was the middle cerebral vertebral arteries<sup>23)</sup>.

In our study, 15 cases of dissecting aneurysms were noted, with the locations of the aneurysms being the vertebrobasilar artery and posterior inferior cerebellar artery. Surgical intervention was performed in 6 cases(0.2%). Direct carotid angiography was primarily performed until early 1990, and showed a low incidence of dissecting aneurysm. Yasargil, et al.<sup>25)</sup>, reported about 20% aneurysm re-clipping, in our study, 14(0.5%) cases were re-clipped; 7 cases with and 7 cases without intraoperative angiography. The most common location of the re-clipped aneurysm was the anterior communicating artery. The occurrence of the incidental aneurysm was, 5.6% for "Stehbens"<sup>20,22)</sup>, 6.5% for "Hashi"<sup>11)</sup>, and 5.6% for "Vajda"<sup>19)</sup>. In our study, 164(5.5%) cases of the incidental aneurysm developed in 3,000 aneurysms. Our results were similar to the those of Stehbens and Vajda<sup>9,20,22)</sup>.

Postoperative complications included ischemic complications due to vasospasm, aggravation of preexisting medical disease, medical complications such as upper gastrointestinal bleeding, pneumonia, pulmonary edema, hydrocephalus.

In our study, 281(9.3%) cases had ischemic complication, 256(8.85%) cases had medical complications. There were 141 (4.6%) cases of hydrocephalus needing a shunt operation. The incidence of hydrocephalus requiring a shunt operation after subarachnoid hemorrhage was 3~19%<sup>21)</sup>, and it was common in the anterior communicating and vertebral arteries<sup>7,14)</sup>.

In our study, a shunt operation due to hydrocephalus was needed in 141 cases. 58(41.1%) cases were located in the anterior communicating artery, 42(30.4%) cases in the internal carotid artery, and 23(16.2%) cases in the middle cerebral artery. Since unexpected complications always happen during operations, it is important to control them.

Cases having intraoperative aneurysm ruptures showed bad prognosis. In aneurysms requiring clippings with lobectomy, of 9 cases of intraoperative rupture occurring, 3 cases survived.

The location of the aneurysms were; 7 in the internal carotid artery, and 1 in the posterior inferior cerebellar artery. Overall surgical results were excellent at 48.7%, good at 39.4%, and with a total favorable outcome of 88%. In the old aged group, where early aneurysm surgery was performed, favorable outcome was 5.5%. If the preoperative patient's condition was good, early aneurysm surgery thereby decreasing morbidity due to rebleeding and vasospasm and shortening the hospitalization period.

In complex artery artery aneurysms, the papaverine solution in the operation field was not used thus decreasing the incidence of vasospasm.

Temporary clipping is sometimes needed in immediate surgery, in difficult dissection cases.

There was a high incidence of rupture. The duration of temporary clipping is safe within 5 minutes. If an intermittent and continuous clip is used, there is a risk of infarction. A bad day for aneurysm surgery is the 4th day after rupture, because of tense brain, difficulty of dissection, no effect using mannitol. In aneurysm surgery, it is necessary to Police the 5 C's : Confidence, Courage, Control, Cooperation, Constant. In the future, unruptured aneurysm surgery will increase due to Human Brain Doc. In posterior circulation aneurysm surgery, endovascular treatment is an increasing trend.

## Conclusion

This study consisted of 3,000 consecutive patients having intracranial aneurysms admitted to the department of neurosurgery of Busan Paik's Hospital, Inje University between January 1980, and June, 15th, 2005. Summer seasonal incidences was lower between 1980 an 1990; however, currently there is no seasonal difference. The incidence of rebleeding was 5.1% in the early operation group, and 16% in the late operation group. Incidence clinical vasospasm was 16.6%, and angiographic vasospasm was 24.1% respectively. Vasospasm incidence decreased to 14.0% from 35% using nimodipine. Overall surgical results were excellent at 48.7%, good at 39.4%, poor at 6.4%, with death occurring 5.5% of the time. The surgical results for the early surgery group according to surgical timing was better, but not statistically significant.

There were 33 cases of aneurysm reoperation including 7 cases of reclipping with intraoperative angiography occurring. Intraoperative angiography was useful especially on large aneurysms of the anterior communicating artery.

Usually people think aneurysm surgery is easy, but unexpected complications can happen. The important thing is to control them. The more aneurysms, the greater difficulty.

## References

1. Adams HP Jr, Kassell NF, Torner JC, Nibbelink DW, Sahs AL : Early management of aneurysmal subarachnoid hemorrhage. A report of the cooperative aneurysm study. *J Neurosurg* 54 : 141-145, 1981
2. Allen GS, Ahn HS, Preziosi TJ, Battye R, Boone SC, Chou SN : Cerebral arterial spasm-controlled trial of nimodipine in patients with subarachnoid hemorrhage. *N Engle J Med* 308 : 619-624, 1983
3. Hman J, Heiskanen O : Effect of nimodipine on the outcome of patients after aneurysmal subarachnoid hemorrhage and surgery. *J Neurosurg* 69 : 683-686, 1988
4. Kassell NF, Torner JC, Clarke H Jr, Jane JA, Adams HP, Kongable GL : The international cooperative study on the timing of aneurysm surgery. Overall management results. *J Neurosurg* 73 : 18-36, 1990
5. Kassell NF, Torner JC, Jane JA, Haley EC Jr, Adams HP : The international cooperative study on the timing of aneurysm surgery. Part 2 : Surgical results. *J Neurosurg* 73 : 37-47, 1990
6. Lee KC, Joo JY, Huh SK, Lee KS : Surgical experience of 1,000 cases of Intracranial Aneurysm - Part 1 : Outcome of Surgical Treatment. *J Korean Neurosurg Soc* 21 : 1599-1606, 1992
7. Mehta V, Holness RO, Connolly K : Acute hydrocephalus following aneurysmal subarachnoid hemorrhage. *Can J Neurol Sci* 23 : 10-15, 1996
8. Miller CA, Hill CA, Hunt WE : "De Novo" Aneurysms. A clinical Review. *Surg Neurol* 24 : 173-180, 1985
9. Mizutani T : Middle cerebral artery dissecting aneurysm with persistent patient pseudolumen. Case Report. *J Neurosurg* 84 : 267-268, 1996
10. Mizutani T, Aruga T, Kirino T, Mikie Y, Saito I, Tsuchida T : Recurrent subarachnoid hemorrhage from untreated ruptured vertebralbasilar dissecting aneurysms. *Neurosurgery* 36 : 905-913, 1995
11. Nakagawa T, Hashi K : The incidence and treatment of asymptomatic, unruptured cerebral aneurysms. *J Neurosurg* 80 : 217-223, 1994
12. Petruk KC, West M, Mohr G, Weir BKA, Benoit BG, Gentili F, et al : Nimodipine treatment in poor grade aneurysm patients. Results of a multicenter double-blind placebo-controlled trial. *J Neurosurg* 68 : 505-517, 1988
13. Philippon J, Grob R, Dageure F, Guggiari M, Rivierez M, Viars P : Prevention of vasospasm in subarachnoid hemorrhage. A controlled study with nimodipine. *Acta Neurochir(Wien)* 82 : 110-114, 1986
14. Pietilia TA, Heimberger KC, Palleske H, Brock M : Influence of aneurysm location on the development of chronic hydrocephalus following SAH. *Acta Neurochir (Wien)* 137 : 70-73, 1995
15. Sahs AI, Perret GE, Loksley HB, Nishioka H, Skultety FM : Preliminary remarks on subarachnoid hemorrhage. *J Neurosurg* 24 : 782-788, 1966
16. Sasaki O, Ogawa H, Koike T, Koizumi T, Tanaka R : A clinicopathological study of dissecting aneurysms of the intracranial vertebral artery. *J Neurosurg* 75 : 874-882, 1991
17. Sim JH : Intracranial Aneurysms in Korea. *Neurol Med Chir (Tokyo) Suppl* 38 : 118-121, 1988
18. Sim JH, Kim SC, Jung YT, Lee SI, Kim MS : Surgical Experience of 1,500 cases of Intracranial Aneurysm. *J Korean Neurosurg Soc* 27 : 898-906, 1998
19. Stehbins WE : Pathology of the Cerebral Blood Vessels. St Louis : Mosby, 1972, pp351-470
20. Stehbins WE : Aneurysms and anatomical variations of cerebral arteries. *Arch Pathol* 75 : 45-64, 1963
21. Tapanihano A, Hernesniemi J, Vapalahti M, Niskanen M, Kari A, Luukkonen M : Shunt dependent hydrocephalus after subarachnoid hemorrhage and aneurysm surgery : timing of surgery is not a risk factor. *Acta Neurochir(Wien)* 123 : 118-124, 1993
22. Vajda J, Juhsz J, Orosz E, Pasztor E, Toth S, Horvath M : Surgical treatment of multiple intracranial aneurysms. *Acta Neurochir* 82 : 14-23, 1986
23. Yamaura A, Waranabe Y, Saeki N : Dissecting aneurysms of the intracranial vertebral artery. *J Neurosurg* 72 : 183-188, 1990
24. Yoshimoto T, Uchida K, Kaneko U, Kayama U, Suzuki J : An analysis of follow-up results of 1000 intracranial saccular aneurysms with definitive surgical treatment. *J Neurosurg* 50 : 152-157, 1979
25. Yasargil MG : Anterior cerebral and anterior communicating artery aneurysms, In Yasargil MG (ed) *Microneurosurgery II clinical considerations, Surgery of the intracranial aneurysms and results*. New York, Georg Thieme Verlag Press, 1984, vol 2, pp165-231