

Surgical Results of Unruptured Intracranial Aneurysms

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Objective : To document surgical mortality and morbidity for the treatment of unruptured intracranial aneurysms, and to identify optimal treatment modalities, the authors reviewed and analyzed the surgical results.

Methods : The authors reviewed 49 cases of unruptured intracranial aneurysm without a previous history of subarachnoid hemorrhage from March 1984 through December 2003. Unruptured intracranial aneurysms were categorized as asymptomatic and symptomatic, and operative results were assessed using the Karnofsky scale at 3 months postoperatively. Outcomes were defined as 'excellent' for a Karnofsky scale score of 100, 'good' for a score of 80-90, 'fair' for 50-70, 'poor' for 10-40, or as 'death'. Excellent and good results were defined as a 'favorable' outcome and others as 'unfavorable' outcome.

Results : Of the 49 study subjects, 45 had a favorable outcome and 4 an unfavorable outcome. Surgical mortality was 6.1% and surgical morbidity was 2.0% for all subjects. And the symptomatic group had more complications.

Conclusion : There were no significant relationships between aneurysmal size, location, and preoperative symptoms with surgical results. And we believe that the reasons for morbidity and mortality are attributable to strokes, thus more attention should be paid to peri- and post-operative patients care with a focus on strokes prevention in the symptomatic group.

KEY WORDS : Unruptured aneurysm · Clipping · Surgical results.

Introduction

Unruptured intracranial aneurysms affects 0.2~8.9% of the population^{3,4,6,7,10}, and despite remarkable medical and operative technique developments, subarachnoid hemorrhage is still associate with high mortality and morbidity rates⁹. Recent Computed Tomography(CT), Magnetic Resonance Imaging(MRI), Magnetic Resonance Angiography (MRA), and Three-Dementional Computed Tomographic Angiography(3DCTA) developments simplify the diagnoses of unruptured intracranial aneurysms. Moreover, outcomes are much improved if aneurysms are treated before rupture, because of the absence of brain injury caused by hemorrhage or increased intracranial pressure and of ischemic injury caused by cerebral edema or vasospasm. Moreover, clear operative fields allow the operator distinguish anatomical structures more easily.

However, the surgical results obtained after the treatment of unruptured intracranial aneurysms are dependent on several factors, namely, the presence of symptoms prior to operation,

aneurysm size and location, patient age and gender, the experiences of operator¹¹.

The aims of the present study were to document surgical mortality and morbidity for the treatment of unruptured intracranial aneurysms, and to identify optimal treatment modalities.

Materials and Methods

Among 1116 cases of intracranial aneurysm operations performed by one neurosurgeon from March 1984 through December 2003, there were 53 cases (4.8%) of unruptured intracranial aneurysm without a previous history of subarachnoid hemorrhage. After excluding four cases that showed a preoperative severe neurologic deficit caused by other cerebro-vascular diseases, we included 49 cases of unruptured intracranial aneurysm in the present study. A retrospective analysis was performed of surgical results and complications with respect to preoperative symptoms, and sizes and locations of aneurysm.

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Table 1. Clinical presentations of unruptured intracranial aneurysms

Symptomatic		Asymptomatic	
Blurred vision	2	Headache	9
3rd CN palsy	13	Dizziness	9
Seizure	2	Dementia	1
Associated vascular disease	10	Occipital numbness	1
ICH	4	CPA tumor	1
Infarction	2		
TIA	4	Syncope	1
Total	27	Total	22

CN : cranial nerve, AVM : arterio-venous malformation, ICH : intracerebral hem-orrhage, TIA : transient ischemic attack, CPA : cerebellopontine angle

There were 19 males (38.8%) and 30 females (61.2%), of mean age 54.8 ± 10.1 years (range, 34~73).

Unruptured intracranial aneurysms were categorized as asymptomatic and symptomatic. There were 27 cases in the symptomatic group. Symptom included blurred vision, 3rd-cranial nerve palsy, seizure, and other cerebro-vascular diseases. The asymptomatic group contained 22 cases. The majority of the aneurysms involved were discovered during examinations conducted for simple headache, dizziness, dementia, occipital numbness, syncope, and brain tumor (Table 1).

The aneurysm sizes were classified as below 10mm, between 10mm and 25mm, and over 25mm, and locations were classified as; internal carotid artery, anterior cerebral artery, middle cerebral artery, posterior cerebral artery or as multiple aneurysms. Aneurysms were clipped in all cases.

Operative results were assessed using the Karnofsky scale at 3 months postoperatively. Outcomes were defined as 'excellent' for a Karnofsky scale score of 100, 'good' for a score of 80~90, 'fair' for 50~70, 'poor' for 10~40, or as 'death'. Excellent and good results were defined as a 'favorable' outcome and others as 'unfavorable' outcome²⁾. Preoperative symptoms and surgical results were analyzed.

The statistical analysis were performed using the statistical program, SPSS Ver. 11 for Windows. The Chi-square test, and the T-test were used to compare surgical results with preoperative symptoms, and aneurysm locations and sizes. P values of <0.05 were considered significant.

Results

Surgical results at 3 months postoperatively showed that 85.2% of patients in the symptomatic group and 100% in the asymptomatic group had a favorable outcome, but without significant intergroup difference (P=0.083, Table 2).

According to aneurysmal size, 26 cases (53.1%) had an aneurysm of below 10mm, 18 cases (36.7%) had an aneurysm between 10mm and 25mm, and 5 (10.2%) an aneurysm of over 25mm. Average aneurysmal size in symptomatic group

Table 2. Relationships between outcome and presence of symptom

Outcome	Symptomatic	Asymptomatic	Total
Favorable	23(85.2%)	22(100%)	45(91.9%)
Unfavorable	4(14.8%)*	0(0%)	4(8.1%)
Total	27	22	49

Favorable : excellent and good results, Unfavorable : fair, poor and death results. *: Unfavorable outcome of symptomatic group includes 3 cases of death

Table 3. Relationships between preoperative symptoms, aneurysmal size and outcome

Size(mm) *	Symptomatic			Asymptomatic			Total †		
	Fv	Ufv	Total	Fv	Ufv	Total	Fv	Ufv	Total
< 10	14	2	16	9	1	10	23	3	26
10~25	7	0	7	11	0	11	18	0	18
≥25	3	1	4	1	0	1	4	1	5
Total	24	3	27	21	1	22	45	4	49

Fv : favorable outcome, Ufv : unfavorable outcome. * : P=0.103 compared with symptomatic and asymptomatic. † : P=0.393 compared with surgical outcome and aneurysmal size

Table 4. Relationships between preoperative symptoms, aneurysmal location and outcome

Location	Symptomatic			Asymptomatic			Total		
	Fv	Ufv	Total	Fv	Ufv	Total	Fv	Ufv	Total
ICA	11	3	14	7	0	7	18	3	21
ACA	4	0	4	5	0	5	9	0	9
MCA	4	0	4	4	0	4	8	0	8
PCA	1	0	1	2	0	2	3	0	3
Multiple	4	0	4	3	1	4	7	1	8
Total	24	3	27	21	1	22	45	4	49

Fv : favorable outcome, Ufv : unfavorable outcome, ICA : internal carotid artery, ACA : anterior cerebral artery, MCA : middle cerebral artery, PCA : posterior cerebral artery

was $11.0\text{mm} \pm 7.8\text{mm}$, and in the asymptomatic group this was $11.5\text{mm} \pm 6.2\text{mm}$, and no significant relation was found between aneurysmal size and preoperative symptoms (p=0.103) nor between aneurysmal size and surgical results (p=0.393, Table 3).

In terms of aneurysmal location, 21 cases (42.9%) had an aneurysm of internal carotid artery, 9 cases (18.4%) of the anterior cerebral artery, 8 (16.3%) of the middle cerebral artery, 3 (6.1%) of the posterior cerebral artery, and 8 (16.3%) had multiple aneurysms. No significant relation was found between aneurysmal location and preoperative symptoms (p=0.156), nor between aneurysmal location and surgical results (p=0.440, Table 4).

Aneurysmal clipping was performed 53 times in the 49 cases. There were 11 cases of surgical complications, namely 4 cases of intracerebral hematoma, 2 cases of seizure, and one case of each of cerebral infarction, acute subdural hematoma, renal failure, fungemia, and second cranial nerve injury. Of the 11 cases that experienced of surgical complications, 5 cases had a post-operative stroke such as intracerebral hematoma, or cerebral infarction. In the symptomatic group, there were 9

Table 5. Review of surgical complications

Complication [§]	Symptomatic	Asymptomatic	Total
S-ICH	4*	—	4
Infarction	1†	—	1
Acute SDH	1‡	—	1
Seizure	1	1	2
Renal failure	1	—	1
Fungemia	1	—	1
II CN injury	—	1	1
Total	9	2	11

S-ICH : spontaneous intracranial hematoma, SDH : subdural hematoma, CN : cranial nerve. * : There are 2 bleedings from previous infarction site, and 2 bleedings from another S-ICH. S-ICH resulted 1 death and 1 fair outcome. † : Death caused by progressive infarction 1 week after ophthalmic artery aneurysmal clip. ‡ : Death caused by acute bleeding around the operation site on 3rd day after operation. § : Symptomatic patient group showed higher rate of complication develops(P=0.043)

Table 6. Causes of unfavorable outcome

Causes	Symptomatic	Asymptomatic	Total
New ICH	2	0	2
Infarction	1	0	1
Acute SDH	1	0	1
Total	4	0	4

ICH : intracerebral hematoma, SDH : subdural hematoma

cases of surgical complications, and 2 cases in the asymptomatic group. And this group difference was significant ($p=0.043$, Table 5).

Of the 49 study subjects, 45 had a favorable outcome and 4 an unfavorable outcome. Three cases (6.1%) with an unfavorable outcome were mortality cases (Table 2), And these were due to a progressing infarction at 7 days postoperatively, acute subdural hematoma caused by avulsion of a small internal cerebral artery branch at 3 days after postoperatively. And third was due to a another spontaneous intracerebral hematoma (Table 5, 6). One morbidity case was caused by a newly developed postoperative intracerebral hematoma and total surgical morbidity was 2.0% (Table 6).

Discussion

Generally, the occurrence of unruptured intracranial aneurysm is about 2~5% at autopsy¹²⁾. Moreover, the continuing developments of non-invasive diagnostic techniques, such as 3DCTA, MRI, and MRA simplify the visualization of unruptured intracranial aneurysms. When considering the poor prognosis of ruptured aneurysm, it is evident that the appropriate treatment is required in the unruptured state.

King et al.⁹⁾ classified unruptured intracranial aneurysms into two groups, i.e., aneurysms found incidentally during examinations undertake on arterio-venous malformations, transient ischemic attacks, intracranial artery occlusions, headaches, dizziness, a deterioration of consciousness, seizure, trauma, metastatic tumor, endocrinologic disease, or for a aneurysm

found during a previous study of a ruptured aneurysm. Crowell et al.⁵⁾ concluded that an aneurysm can stimulate the cerebral cortex and cause seizure and that cerebro-vascular disease can afford some effects to the patient's symptom. In the present study, we classified aneurysms found during the study of cerebro-vascular diseases, as 'symptomatic' group, and we excluded unruptured intracranial aneurysm which was found during a previous study of a ruptured aneurysm. In the present study, we classified patients into two groups, i.e., a symptomatic group and an asymptomatic group.

Several studies have reported that symptomatic aneurysms are larger and have a higher rupture rate^{10,17)}. Solomon et al.¹⁵⁾ reported that aneurysmal size affects surgical results, if the size of an aneurysm is below 10mm, surgical morbidity is about 1%, but this increased to 5% between 10mm and 25mm and exceeds 20% when over 25mm. However, in the present study, unlike previous studies, no significant difference was found between symptom type and aneurysm size, nor between symptom and surgical results ($p=0.103, 0.393$).

Wirth et al.¹⁶⁾ reported that surgical morbidity in intracranial artery aneurysm cases is 8.1%, in ophthalmic artery aneurysm cases is 11.8%, and in anterior cerebral artery aneurysm cases is 15.5%, and found that aneurysmal location can affect surgical results. Moreover, according to an International Study of Unruptured Intracranial Aneurysms(ISUIA) conducted between 1991 and 1998, patient age, aneurysm size and location are important surgical prognostic factors¹¹⁾. However in the present study, no significant relation was found between aneurysm locations and symptoms, nor between aneurysm sizes and symptoms, even though there was tendency like previous studies ($p=0.156, 0.440$). We attribute this lack of a relation to the relatively small number of patients enrolled.

Juvela et al.⁸⁾ reported that the surgical risk of morbidity and mortality of unruptured intracranial aneurysm is 10~16%, but the majority of studies have reported lower figures for morbidity and mortality, i.e., 4.1~7.3% and 0~1.0% respectively^{9,13,14,16)}.

In the present study, surgical mortality was 6.1% and surgical morbidity was 2.0% for all subjects. The asymptomatic group had no surgical morbidity or mortality, but the symptomatic group had a surgical mortality of 11.1% and a surgical morbidity of 3.7%. Furthermore, the symptomatic group had more complications ($p=0.043$). We believe that the reasons for these morbidity and mortality figures are attributable to strokes, e.g., newly developed cerebral hemorrhage, and cerebral infarction postoperatively. These finding indicate that more attention should be paid to peri- and post-operative patients care with a focus on strokes prevention, then we may expect better surgical results.

Conclusion

Of the 49 study subjects, 45 had a favorable outcome and 4 an unfavorable outcome. Surgical mortality was 6.1% and surgical morbidity was 2.0%. And the symptomatic group had more complications. There were no significant relationships between aneurysmal size, location and preoperative symptoms with surgical results. We believe that the reason for morbidity and mortality are attributable to stroke, thus more attention should be paid to symptomatic patients with a special focus on stroke prevention.

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Commentary

Treatment of patients with an unruptured intracranial aneurysm is still controversial. There is three options : surgical clipping, endovascular coil embolization, and observation. The decision making about management should be based on the risk of aneurysm rupture and the risks associated with surgical or endovascular intervention.

Authors analyzed surgical treatment of 49 unruptured intracranial aneurysms. About 6% mortality and 2% morbidity is somewhat higher than naturally bleeding rate of an aneurysm (1~3.42% per year). Surgical outcome was influenced by the presence of concurrent diseases, patient age, size and location of the aneurysms⁵). Since the rupture rate of unruptured aneurysms without SAH history is reported to be low, surgical indication should be considered with care³). Nowadays, endovascular treatment is a little bit superior outcome rate (0% mortality and 3.1~3.7% morbidity)^{2,4,5}). So we should take into account the factors such as aneurysm bleeding rate, its location, surgical or endovascular accessibility, the patient's general medical condition, and the individual's treatment preference to determine the choice of therapies¹), especially for symptomatic patients. A team approach by neurosurgeons and endovascular interventionists is recommended to evaluate each patient and to tailor the best treatment plan.

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