

# Risk Factors Affecting Clinical Outcome of Ruptured Vertebrobasilar Saccular Aneurysms

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**Objective** : Ruptured vertebrobasilar (VB) saccular aneurysm is a difficult lesion to treat, and is associated with high rates of morbidity and mortality. The aim of this study is to investigate the risk factors associated with the clinical outcome of ruptured VB aneurysms.

**Methods** : A retrospective review of 29 patients with ruptured VB saccular aneurysms between 2002 and 2010 was conducted between Jan 2002 and Dec 2010. Univariate and multivariate analyses were performed for determination of the statistical significance of the Glasgow Outcome Scale (GOS) at three months, according to age, initial Hunt-Hess grade, the presence of acute hydrocephalus, and treatment modality.

**Results** : The study included 24 (82.7%) females and five (17.3%) males, with a mean age of 59 years (range, 22–78 years). Seventeen patients were treated with surgical clipping and 12 patients were treated with endovascular coil embolization. No statistical significance was observed between clinical outcome and treatment modalities (clipping or coiling;  $p = 0.803$ ). Seventeen (58.6%) patients achieved favorable outcome, defined as GOS score of 4-5, at 3 months. Procedure-related complications occurred in seven patients (24.1%). Results of multivariate analysis indicated that initial Hunt-Hess grade and the presence of acute hydrocephalus were independent predictors of unfavorable outcome, defined as GOS score of 1-3 [Odds ratio (OR) = 8.63, Confidence interval (CI) [95%] 1.11–66.84,  $p = 0.039$  and OR = 36.64, CI [95%] 2.23–599.54,  $p = 0.012$ , respectively].

**Conclusion** : The present study suggests that the clinical outcomes are related to the initial Hunt-Hess grade and the presence of acute hydrocephalus in ruptured saccular VB aneurysms.

**Keywords** Aneurysm, Outcome, Risk factor, Vertebrobasilar

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## INTRODUCTION

Ruptured vertebrobasilar (VB) saccular aneurysms account for 2.7-5% of ruptured intracranial aneurysms.<sup>8)18)</sup> For the past several decades, surgical clipping has been the standard treatment for ruptured VB aneurysms.<sup>13)18)</sup> However, in recent years, the use of

endovascular coiling has become more common. In recent randomized trials, the relative risk of unfavorable outcomes for coiling versus clipping was 0.41, with an absolute decrease in risk of 27%. The authors reported that coiling was the preferred modality for patients with ruptured VB aneurysms.<sup>16)</sup>

Nonetheless, the rates of morbidity and mortality

for ruptured VB aneurysms remain high.<sup>17)18)</sup> In a large series of 342 ruptured VB aneurysms, favorable outcomes at three months were achieved in 59% of cases and the mortality rate was 27%.<sup>18)</sup>

To the best of our knowledge, few reports investigating the risk factors associated with clinical outcome after endovascular coiling in patients with ruptured posterior inferior cerebellar artery aneurysms have been reported.<sup>5)7)</sup> Also, few studies of risk factors associated with clinical outcome in ruptured VB aneurysms can be found in the literature.<sup>3)11)13)</sup> Therefore, we performed a detailed review of the clinical outcomes of patients with ruptured VB saccular aneurysms and analyzed the risk factors associated with unfavorable outcomes.

## MATERIALS AND METHODS

### Patient population

We retrospectively collected demographic, clinical, and radiographic data of 29 patients with ruptured VB aneurysms who underwent surgical clipping or endovascular coiling between January 2002 and December 2010. All patients had a ruptured saccular aneurysm of the VB system that was identified using brain computed tomographic (CT) angiography and cerebral digital subtraction angiography. Patients with dissecting or fusiform aneurysms were excluded from this study.

### Surgical and endovascular procedure

From 2002 to 2007, our neurovascular team primarily used surgical clipping for treatment of VB aneurysms. Since 2008, following improvements in endovascular technique, endovascular coiling became the primary treatment method used in our institute. Currently, when endovascular coiling fails due to the presence of a tortuous vessel, we treat aneurysms with surgical clipping.

Standard pterional, orbitozygomatic, and suboccipital retro-sigmoid approaches were used in performance of surgical procedures, according to the location of

the aneurysm. When acute hydrocephalus occurred, we attempted external ventricular drainage (EVD).

Endovascular coiling was performed in the angiography suite under general anesthesia. In cases of acute hydrocephalus, EVD was performed before endovascular coiling. The trans-femoral route was used and a 5- or 6-Fr guiding catheter was placed in the vertebral artery. Using fluoroscopy and road mapping, an Excelsior SL-10 microcatheter (Boston Scientific, Natick, MA) was navigated into the aneurysm with the aid of a Synchro-14 microguidewire (Boston Scientific, Natick, MA). An intravenous bolus injection of 3,000 to 5,000 IU of heparin was administered after deployment of the first coil, followed by 1,000 IU/hour of heparin. Most of the currently available bare platinum coils have been used for obliteration of aneurysms. We did not use a stent and functional coils.

### Statistical analysis

The following factors were included in the analyses: sex, age, initial Hunt-Hess grade, Fisher's grade, aneurysm location and size, treatment modalities, the presence of acute hydrocephalus, symptomatic vasospasm, and Glasgow Outcome Scale (GOS) at three months. Hunt-Hess grade was used for evaluation of initial neurological status. GOS was used to assess the level of disability at three-month follow-up. We considered GOS 4 and 5 as favorable outcomes and GOS 1-3 as unfavorable outcomes. Comparisons were made for determination of the risk factors affecting clinical outcomes at three months after the initial subarachnoid hemorrhage. Statistical analysis was performed using commercial software (SPSS, version 13.0, SPSS Inc.). All data are presented as mean  $\pm$  standard deviation. In univariate analysis, the independent Mann-Whitney U test and Fisher's exact test were used for analysis of statistical significance of independent variables between groups. A value of  $p < 0.05$  was considered statistically significant. In multivariate analysis, we performed binary logistic regression analysis using variable factors which were known to affect outcomes in literature review.

**Table 1. Demographic and clinical data for 29 patients with ruptured vertebrobasilar saccular aneurysms**

Variables	Values
No. of patients	29
Sex (M/F)	5/24
Age (years, mean $\pm$ SD)	59.34 $\pm$ 13.14
Hunt-Hess grade	
II	11
III	7
IV	8
V	3
Fisher grade	
II	6
III	10
IV	13
Aneurysm location	
PCA	3
Basilar tip	16
SCA	3
PICA	7
Aneurysm size	
<10 mm	24
$\geq$ 10 mm	5
Acute hydrocephalus	
Yes	11
No	18
Symptomatic vasospasm	
Yes	2
No	27
Treatment modality	
Clipping	17
Coiling	12
Procedure-related complications	
Perforator injury	4
Cranial nerve palsy	1
Cerebellar hemorrhage	2
Glasgow Outcome Scale	
1	4
2	3
3	5
4	6
5	11

M = male; F = female; SD = standard deviation; PCA = posterior cerebral artery; SCA = superior cerebellar artery; PICA = posterior inferior cerebellar artery

## RESULTS

### Demographic and clinical outcomes

The mean age of patients was 59.3  $\pm$  13.1 years; five were males (17.2%) and 24 were females (82.8%). Initial Hunt-Hess grades were good (grade I, II, III) in 18 patients (62%) and poor (grade IV and V) in 11 patients (38%). A summary of the locations and sizes of aneurysms is shown in Table 1. The most frequent type was basilar tip aneurysm (55.1%), followed by posterior inferior cerebellar artery aneurysm (24.1%). Seventeen patients (58.65) were treated with surgical clipping and 12 patients (41.4%) were treated with en-

dovascular coil embolization. Acute hydrocephalus occurred in 11 patients (37.9%).

In the clipping group, 13 (76.4%) aneurysms were located on the basilar tip, followed by three posterior inferior cerebellar arteries and one superior cerebellar artery. There were six procedure-related complications (35.2%); four perforator injury, one remote cerebellar hemorrhage, and one temporary lower cranial nerve palsy.

In the coiling group, four (33.3%) aneurysms were located on the posterior inferior cerebellar artery, followed by three posterior cerebral arteries, three basilar tips, and two superior cerebellar arteries. There was one procedure-related complication (8.3%); cerebellar hemorrhage of unknown origin.

After three months, 17 patients (58.6%) had favorable outcomes and 12 patients (41.4%) had unfavorable outcomes. We did not experience patients with re-bleeding of any treated aneurysms during the follow-up period.

### Risk factors affecting outcome

Results of univariate analysis revealed that the presence of acute hydrocephalus was statistically significant between the favorable and unfavorable outcome groups ( $p = 0.018$ ), whereas no statistical significance was observed in age, initial Hunt-Hess grade, or aneurysm location ( $p = 0.296$ ,  $0.119$ , and  $0.494$ , respectively). No differences in treatment modalities were observed between the two groups ( $p = 1.000$ ) and procedure-related complications tended to higher in the surgical clipping group ( $p = 0.092$ ). A summary of the univariate analysis of the clinical outcome according to various factors is shown in Table 2.

Results of multivariate analysis indicated that initial Hunt-Hess grade IV-V and the presence of acute hydrocephalus were independent predictors of unfavorable outcomes (odds ratio (OR) = 8.63, 95% confidence interval (CI) 1.11-66.84,  $p = 0.039$ , and OR = 36.64, 95% CI 2.23-599.54,  $p = 0.012$ , respectively, Table 3).

**Table 2. Baseline characteristics of the two study groups**

Variables	Favorable (n = 17)	Unfavorable (n = 12)	p value
Female	14	10	1.000
Age (years)			0.296
< 60	9	4	
≥ 60	8	8	
Initial Hunt-Hess grade			0.119
II, III	13	5	
IV, V	4	7	
Fisher grade			0.308
II	5	1	
III	6	4	
IV	6	7	
Aneurysm location			0.494
PCA	2	1	
Basilar tip	9	7	
SCA	3	0	
PICA	3	4	
Aneurysm size			1.000
< 10 mm	14	10	
≥ 10 mm	3	2	
Treatment modalities			1.000
Clipping	10	7	
Coiling	7	5	
Acute hydrocephalus			0.018
Yes	3	8	
No	14	4	
Symptomatic vasospasm			1.000
Yes	1	1	
No	16	11	

GOS = Glasgow Outcome Scale

**Table 3. Multivariate analysis of predictors of unfavorable outcomes of patients with ruptured vertebrobasilar saccular aneurysms**

Variables	Adjusted OR	95% CI	p value
Age	3.67	0.58–23.02	0.165
Initial Hunt-Hess grade IV-V	8.63	1.11–66.84	0.039
Acute hydrocephalus	36.64	2.23–599.54	0.012
Treatment modalities	0.50	0.07–3.38	0.482

OR = odds ratio; CI = confidence interval

## DISCUSSION

Endovascular coil embolization for treatment of ruptured VB aneurysms is now widely performed; however, treatment of ruptured VB saccular aneurysms is still difficult and is associated with significant morbidity and mortality. Few studies have examined the risk factors associated with clinical outcome in ruptured posterior circulation aneurysms.<sup>3)11)13)</sup> Therefore, we attempted to clarify the factors affecting clinical outcomes in these patients.

Results of the current study indicated that initial poor Hunt-Hess grade was a risk factor associated with unfavorable outcome. In accordance with our result, Hillman<sup>3)</sup> reported that neurological status at initial presentation to the hospital was the most important factor associated with clinical outcome in posterior circulation aneurysms. In a retrospective study of 189 patients, one author suggested that the outcomes were related to Hunt-Hess grade at presentation, aneurysm size, patient age, and density of subarachnoid hemorrhage as variable factors affecting the clinical outcomes of the posterior circulation aneurysm.<sup>11)</sup> On the other hand, another study reported that patient age and aneurysm location are the most important factors affecting prognosis in ruptured posterior circulation aneurysms.<sup>13)</sup>

Preoperative Hunt-Hess grade and the presence of acute hydrocephalus at symptom onset have been reported as risk factors.<sup>7)</sup> Ruptured VB aneurysms are associated with a higher incidence of intraventricular hemorrhage, which can cause acute hydrocephalus. In a study involving a series of 31 posterior inferior cerebellar artery aneurysms, the authors suggested the importance of emergent placement of a drainage catheter.<sup>7)</sup> Also, in the case of acute hydrocephalus, before performing definitive treatment, we initially attempted to implement external ventricular drainage.

In choosing the treatment modality for ruptured VB aneurysm, various factors, including patient's clinical status, aneurysm size and location, and method of approach must be considered. Among these various factors, the choice of an appropriate method (surgical clipping or endovascular coiling) is important to achievement of a better outcome. Endovascular coil embolization for treatment of ruptured VB aneurysms is performed due to the difficulties of surgical access and complications such as the injury of cranial nerve and perforating vessel. However, endovascular coiling is not always feasible. The tortuous and atherosclerotic blood vessel may prevent navigation of the catheter into the aneurysm sac. Procedure-related complications such as aneurysm perforation and thromboemb-

olism may also occur.

In 2002, findings of the International Subarachnoid Aneurysm Trial (ISAT) indicated better short-term outcomes for ruptured aneurysms treated with coiling than those treated with clipping but, a higher rebleeding rate after endovascular coiling.<sup>8)</sup> However, many authors have recently reported that endovascular coiling is the preferred treatment for patient with ruptured VB aneurysms and is associated with good clinical results compared with clipping.<sup>6)10)12)15)16)</sup> Despite increasing preference for the use of endovascular coiling for treatment of VB aneurysms, Sanai et al.<sup>14)</sup> proposed that, for both surgical and anatomic reasons, surgical clipping is a primary therapy for treatment of superior cerebellar artery, P1 posterior cerebral artery, distal anteroinferior cerebellar artery, and posteroinferior cerebellar artery aneurysms. ISAT recently reported similar long-term results in two groups.<sup>9)</sup> Bakker and colleagues<sup>1)</sup> reported that in terms of clinical decision-making, coiling and clipping are long-term equals. In our study, no significant difference in clinical outcome was observed between the clipping and coiling groups ( $p = 1.000$ ).

One retrospective study reported a procedure-related morbidity rate of 30% in the clipping group and 9.5% in the coiling group in management of a basilar apex aneurysm.<sup>2)</sup> In our study, we found that procedure-related morbidity is more frequent in the clipping group (35.2% vs. 8.3%).

In our study, symptomatic vasospasm was observed in only two patients. Accordingly, in contrast with anterior circulation aneurysms, symptomatic vasospasm does not affect clinical outcome. As previously reported, this finding may be attributed to the better collateral channels of posterior circulation.<sup>4)</sup> Further studies will elucidate the causal relationship between clinical outcome and symptomatic vasospasm.

Our study has several limitations. First, it is inherently limited by its retrospective design and small number of enrolled patients. Second, characteristics of patients and aneurysms and treatment modalities are heterogenous. Patients underwent surgical clipping

before 2008, whereas endovascular coiling was performed after 2008. Therefore, direct comparisons of the clinical outcomes of this population may confound our results.

## CONCLUSION

In this study, we found that the clinical outcomes were related to the initial Hunt-Hess grade and the presence of acute hydrocephalus in ruptured saccular VB aneurysms. Further investigations will be needed in order to clarify the risk factors affecting clinical outcomes in these aneurysms.

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