

Clinical Article

Predicting Factors Affecting Clinical Outcomes for Saccular Aneurysms of Posterior Inferior Cerebellar Artery with Subarachnoid Hemorrhage

Young-Ho Hong, M.D.,¹ Chang-Hyun Kim, M.D.,² Gil-Sung Che, M.D.,¹ Sang-Hoon Lee, M.D.,² Chang-Gu Ghang, M.D.,¹ Yu-Seok Choi, M.D.²

¹Department of Neurosurgery, Cerebro-Vascular Center, Bongseng Memorial Hospital, Busan, Korea

²Department of Neurosurgery, Cerebro-Vascular Center, Dong-Rae Bongseng Hospital, Busan, Korea

Objective : The aim of this study is to investigate the clinical outcomes of surgery and coiling and analyze the predicting factors affecting the clinical outcomes of ruptured posterior inferior cerebellar artery (PICA) aneurysms.

Methods : During the last 15 years, 20 consecutive patients with ruptured PICA aneurysms were treated and these patients were included in this study. The Fisher's exact test was used for the statistical significance of Glasgow Outcome Scale (GOS) according to initial Hunt-Hess (H-H) grade, treatment modalities, and the presence of acute hydrocephalus.

Results : Eleven (55%) and nine (45%) patients were treated with surgical clipping and endovascular treatment, respectively. Among 20 patients, thirteen (65.0%) patients had good outcomes (GOS 4 or 5). There was the statistical significance between initial poor H-H grade, the presence of acute hydrocephalus and poor GOS.

Conclusion : In our study, we suggest that initial H-H grade and the presence of acute hydrocephalus may affect the clinical outcome rather than treatment modalities in the ruptured PICA aneurysms.

Key Words : Aneurysm · Endovascular treatment · Posterior inferior cerebellar artery · Subarachnoid hemorrhage · Surgical clipping.

INTRODUCTION

In view of location, posterior inferior cerebellar artery (PICA) aneurysms are reported to most frequently occur in the region where PICA originates in the vertebral artery (VA)^{8,12}. When surgical clipping is performed, there are some risks of neurological complications because of the intimate anatomical relationships of the proximal PICA to the brain stem and lower cranial nerves^{2,4,11}. Because of difficulty in general anesthesia due to poor general condition, recent advancement in endovascular surgery, and difficulties related with surgery, endovascular treatment is being used as a primary or alternative method for treating these aneurysms^{3,6}.

For ruptured or unruptured PICA aneurysms, in our knowledge, many authors^{2,4,7,8,14,15} reported the clinical outcomes of surgery or endovascular treatment, but there was only one

study that analyzed the predicting factors of clinical outcome¹³. We experienced 20 patients for PICA aneurysms with subarachnoid hemorrhage (SAH). And so, we investigated the clinical outcomes after surgery and endovascular treatment and tried to find the predicting factors affecting the outcomes for ruptured PICA aneurysms.

MATERIALS AND METHODS

Patient populations

Between April 1996 and December 2010, 1960 intracranial aneurysms were treated at our institution. Among them, we retrospectively reviewed 20 patients of PICA aneurysms with SAH, of which there were 18 females and 2 males with a mean age of 55.9 (range 42-86 years). In our study, all aneurysms were included except fusiform and dissecting aneurysms. Among them, eleven cases were treated with surgical clipping and 9 cases were treated with endovascular treatment. Patients' data include age, sex, side and location of aneurysm, initial Hunt-Hess (H-H) grade, procedure-related complications, follow-up duration, and Glasgow Outcome Scale (GOS) at last follow-up visit. According to GOS, we categorized the two groups into good (GOS 4 and 5) and poor (GOS 1-3) for the statistical anal-

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• Address for reprints : Yu-Seok Choi, M.D.

Department of Neurosurgery, Dong-Rae Bongseng Hospital, 766 Allak 1-dong, Dongrae-gu, Busan 607-712, Korea

Tel : +82-51-520-5642, Fax : +82-51-520-5793

E-mail : cys1226@hanmail.net

ysis. Mean follow-up duration was an average of 14.8 months after the treatment (range 7 days-36 months).

Surgical procedures

All surgeries were performed by two surgeons at two institutes. We performed the surgical clipping for eight (72.7%) anterior medullary segment aneurysms via a lateral suboccipital craniotomy (LSOC). Once the dura has been opened, the proximal intradural VA was located immediately medial to cranial nerve XI. Sharp dissection along the VA was performed until the distal VA was exposed. The PICA origin was then found near the origin of cranial nerve XII. After proximal and distal control has been achieved, the aneurysm neck was identified using sharp dissection and was finally clipped. Two (18.2%) patients with anterior medullary segment aneurysm underwent surgical clipping via far lateral suboccipital craniotomy (FLSOC) for the deep location and 1 (9.1%) televelo-tonsillar segment aneurysm was clipped via midline suboccipital approach.

Endovascular procedures

The endovascular procedure was performed in the neuroangiography suite equipped with a biplane, high-resolution angiography system. For all patients, the procedure was performed under general anesthesia. Intra-arterial heparin was infused only after packing the aneurysm dome. A 6-F guiding catheter system (Envoy, Codman Neurovascular and Chaperon, Microvention) was introduced via the femoral artery. Variable microcatheters (Excelsior SL-10, Boston Scientific; Echelon-10, ev3; Prowler 14, Codman Neurovascular) and micro-guidewires (Synchro, Boston Scientific; Agility-14, Codman Neurovascular; Traxcess-014, Microvention) were used and then placed into the aneurysm with conventional technique. Seven aneurysms (77.8%) were located in the anterior medullary segment; one (11.1%), in the lateral medullary segment; and one (11.1%) in the tonsilo-medullary segment. All of the coiling was performed using bare platinum coil. We achieved the coil embolization using 8 (88.9%) single and 1 (11.1%) double-catheter techniques. Usually, follow-up angiography was performed at 1-year visit; however, follow-up angiography at 1 year was done in only two (22.2%) patient because of follow-up loss and short follow-up duration.

Statistical analysis

Statistical analysis was performed with commercial software (SPSS, version 15.0, SPSS Inc.). The Fisher's exact test was used for the statistical significance of the independent variables between two groups according to clinical outcomes. A *p*-value of less than 0.05 was considered significant.

RESULTS

Eleven patients underwent surgical clipping and nine were treated with endovascular coiling. Thirteen of the 20 (65.0%)

patients had the left-sided PICA aneurysms. Twelve patients had good initial H-H grade and 8 patients had poor grade. One patient presented with H-H grade 2, but H-H grade aggravated to grade 4 due to re-bleeding. This patient was included in poor H-H grade group. Thirteen of 20 (65.0%) patients in this study had good GOS at last follow-up visit. Ten (83.3%) of 12 patients who presented with a good H-H grade had good outcomes at the last follow-up visit. However, only three (37.5%) of 8 patients with poor H-H grade had good outcomes. According to acute hydrocephalus, twelve (60%) of 20 patients had acute hydrocephalus. External ventricular drainage (EVD) was performed in all patients. Among them, four (33.3%) patients underwent ventriculo-peritoneal shunt.

Six (30.0%) patients with ruptured PICA aneurysms died. There was no procedure-related mortality. Complications included one ventriculitis that occurred after EVD, 4 patients with hospital acquired pneumonia and sepsis, and 1 patient with internal carotid artery (ICA) territory infarction secondary to vasospasm.

Surgical clipping

We achieved the complete clipping in all cases without neck remnant. The mean age of surgical clipping group was 53.7±11.7 (range 42-86 years). There were two (18.2%) male and 9 (81.8%) female. Six (54.5%) patients presented with good initial H-H grade and 5 (45.5%) patients presented with poor H-H grade. Eight patients in the surgically-treated group developed acute hydrocephalus. All of these patients required the emergent EVD. One (No. 2) patient presented with SAH and acute hydrocephalus. After the emergent EVD, trans-femoral cerebral angiography showed the ruptured PICA aneurysm in the anterior-medullary segment. Because of very wide-necked aneurysm, surgical clipping was achieved. The ventriculo-peritoneal shunt was done for obstructive hydrocephalus (Fig. 1). According to clinical outcomes, eight (72.7%) patients showed good outcomes and 3 (27.3%) patients had poor outcomes. Procedure-related complications occurred in two patients, such as 1 swallowing difficulty and 1 vocal cord palsy. The summary of eleven patients with PICA aneurysms who were treated with surgical clipping was listed in Table 1.

Endovascular treatment

In the initial result of coil embolization, there were seven (77.8%) aneurysms with complete occlusion, 1 (11.1%) aneurysm with neck remnant, and 1 (11.1%) residual aneurysm. The mean age of endovascular coiling group was 58.6±12.5 (range 42-76 years). All patients were female. Six (66.7%) patients presented with good H-H grade and 3 (33.3%) patients presented with poor H-H grade. Five (55.6%) of all patients showed good outcomes and 4 (44.4%) showed poor outcomes at the last follow-up visit. As mentioned above, one-year follow-up angiography was performed in only 2 patients (No. 3 and 5). Initially, one (No. 3) patient had residual aneurysm after coiling

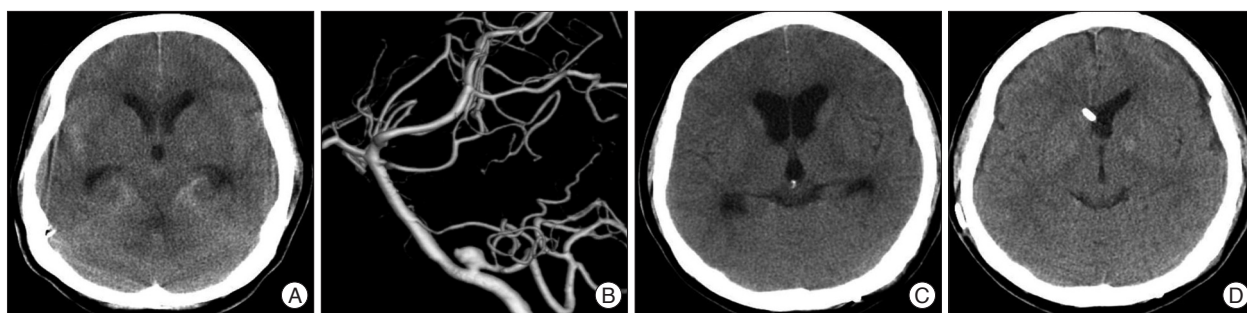


Fig. 1. Surgery case 2. A 86-year-old female presents with subarachnoid hemorrhage due to a ruptured posterior inferior cerebellar artery (PICA) aneurysm of the anterior-medullary segment. A : Preoperative CT shows the hemorrhages in the pre-pontine and basal cistern, and in the fourth ventricle. B : Preoperative 3D-angiogram reveals a wide-necked PICA aneurysm with daughter sac in the anterior-medullary segment. C : Three-week follow-up CT shows obstructive hydrocephalus. D : One-year follow-up CT demonstrates decrease of the ventricle size after the ventriculo-peritoneal shunt.

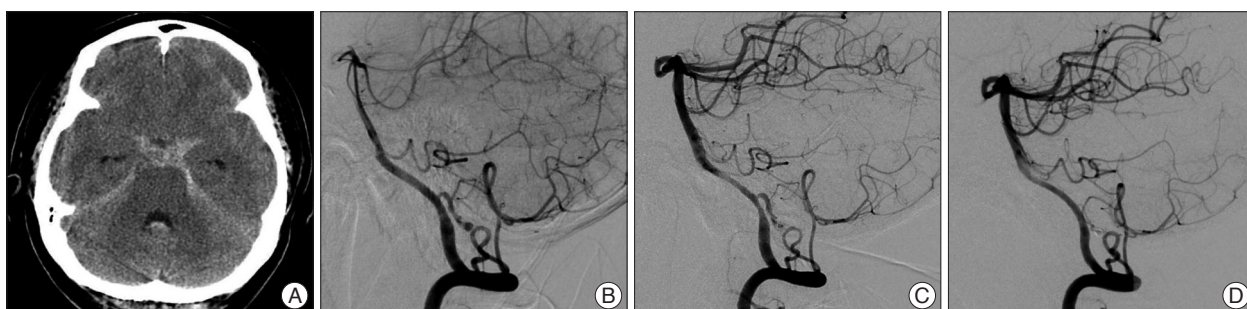


Fig. 2. Coiling case 3. A 46-year-old female presents with subarachnoid hemorrhage due to a ruptured posterior inferior cerebellar artery (PICA) aneurysm which is located in the tonsillo-medullary segment. A : Preoperative CT shows a hemorrhages in the peri-mesencephalic and both Sylvian fissure, and acute hydrocephalus. B : Lateral projection angiogram shows the aneurysm arising from the tonsillo-medullary segment of the left PICA. C : Post-coiling angiogram shows slight contrast filling within the body of aneurysm due to kick back of microcatheter. D : Fourteen-month follow-up angiogram demonstrates no contrast filling within the aneurysm.

Table 1. The summary of clinical characteristics and results of 11 patients treated with surgical clipping for ruptured saccular PICA aneurysms

No.	Age/Sex	H-H grade	Side	Location	GOS	Acute HDC	F/U duration (mos)	Procedure related complication	Reasons for death
1	45/F	5	Rt	Telovelotonsillar	4	+	24		
2	86/F	4	Lt	Anterior medullary	4	+	33		
3	48/F	4	Lt	Anterior medullary	4	+	12	Swallowing difficulty	
4	51/M	3	Rt	Anterior medullary	1	+	0.3		Pneumonia
5	60/F	3	Lt	Anterior medullary	4	+	36		
6	51/F	3	Lt	Anterior medullary	4	-	9	Vocal cord palsy	
7	42/F	3	Lt	Anterior medullary	5	-	12		
8	52/F	4	Lt	Anterior medullary	1	+	0.8		Vasospasm
9	54/F	3	Rt	Anterior medullary	5	-	12		
10	48/M	4	Lt	Anterior medullary	1	+	0		Ventriculitis
11	54/F	3	Lt	Anterior medullary	5	-	14		

H-H : Hunt-Hess, GOS : Glasgow Outcome Scale, HDC : hydrocephalus, F/U : follow-up, mos : months, PICA : posterior inferior cerebellar artery

(Fig. 2) and another (No. 5) patient showed complete occlusion. One residual aneurysm after initial coiling showed no contrast filling in the aneurysm dome at 1-year follow-up angiography. One completely coiled aneurysm revealed no recanalization. But, follow-up angiography was not available in seven patients. The procedure-related complication occurred in one patient; because of embolic infarction, right ankle drop developed. The summary of nine patients with PICA aneurysms who underwent the coiling is listed in Table 2.

Analysis between variable factors and clinical outcome

As mentioned above, we classified the two groups to good (GOS 4 and 5) and poor (GOS 1-3). First, there were the statistical significance between good initial H-H grade and good GOS ($p=0.05$). And then, the presence of acute hydrocephalus and poor GOS was associated with statistical significance ($p=0.01$) in our study. In the analysis of clinical outcomes according to treatment modalities, however, there was no statistical significance between surgical clipping and coiling ($p=0.37$).

Table 2. The summary of clinical characteristics of 9 patients treated with endovascular treatment for ruptured saccular PICA aneurysms

No.	Age/Sex	H-H grade	Side	Location	Initial occlusion grade	GOS	Acute HDC	F/U duration (mos)	method	procedure related complication	Reasons for death
1	76/F	4	Rt	Anterior medullary	CO	1	+	0.3	SC		Pneumonia
2	42/F	2	Rt	Anterior medullary	CO	5	+	36	DC		
3	46/F	3	Lt	Tonsillomedullary	RA	5	-	18	SC		
4	51/F	3	Lt	Anterior medullary	CO	4	-	24	SC	Thrombo-embolism	
5	58/F	2	Rt	Anterior medullary	CO	5	-	36	SC		
6	72/F	2	Lt	Anterior medullary	CO	1	+	1	SC		Pneumonia
7	73/F	4	Rt	Lateral medullary	NR	3	+	5	SC		
8	68/F	4	Lt	Anterior medullary	CO	1	+	0.5	SC		Pneumonia
9	57/F	3	Lt	Anterior medullary	CO	4	-	20	SC		

H-H : Hunt-Hess, GOS : Glasgow Outcome Scale, HDC : hydrocephalus, F/U : follow-up, mos : months, CO : complete occlusion, RA : residual aneurysm, NR : neck remnant, SC : single catheter, DC : double catheter, PICA : posterior inferior cerebellar artery

Table 3. Univariate analysis of Glasgow Outcome Scale (GOS) according to variable clinical characteristics

Variables	GOS		p-value
	Poor (0-3)	Good (4-5)	
Age			
>70	3 (42.9%)	1 (7.7%)	0.101
<70	4 (57.1%)	12 (92.3%)	
Initial H-H grade			
Poor	5 (71.4%)	3 (23.1%)	0.05
Good	2 (28.6%)	10 (76.9%)	
Treatment modalities			
Clipping	3 (42.9%)	8 (61.5%)	0.37
Coiling	4 (57.1%)	5 (38.5%)	
Acute hydrocephalus			
Yes	7 (100%)	5 (38.5%)	0.01
No	0 (0%)	8 (61.5%)	

Univariate analysis of clinical outcome according to variable factors was listed in Table 3.

DISCUSSION

PICA aneurysms are more prevalent in female than in male, and 80% or more of such cases have been reported to occur in the anterior medullary segment^{2,4,11,13}. Also, according to the side, the left VA is under more hemodynamic stress than the right VA because it is larger and carries more blood than the right VA does. Because of this, PICA aneurysm is reported to be more prevalent in the left than in the right side^{1,5}. In our study, PICA aneurysms occurred more frequently in female (90.0%), and most frequently occurring in the anterior medullary segment (85.0%). They developed in the left side (65.0%, 13 patients) than in the right side (35.0%, 7 patients).

Clinical outcomes of surgical clipping

There were a variety of literatures on the clinical outcomes and complications with ruptured PICA aneurysms. It was reported that of the 52 patients who underwent surgery via LSOC, LCNP

developed in 25 (48%) patients. Of these 52 patients, 47 (79.8%) showed good outcome and 1 (1.9%) died due to cardiomyopathy during the period of follow up². Another author reported that 24 (88.9%) of the 27 patients showed good outcome and 2 (7.4%) died at 1-year follow up⁷. Concerning the postoperative complication, it was reported that of the 19 patients who were treated with FL-SOC, 2 (11%) developed transient vocal cord palsy⁴. In our study, eight (72.7%) of the 11 patients treated with surgical clipping showed good outcome while 3 died (1 pneumonia; 1 ICA territory infarction caused by vasospasm; and 1 ventriculitis after EVD).

Clinical outcomes of endovascular treatment

In the study with 23 patients treated with endovascular embolization of ruptured PICA aneurysm, one author reported that procedure-related morbidity was 13% with no procedure-related death and good outcome in 86.4%¹⁴. Another author reported that endovascular coiling of posterior circulation aneurysm including PICA aneurysm in 8 patients had good outcome in 77.2%¹⁵. In our study, 5 (55.6%) of the 9 patients who received endovascular coiling showed good outcome. There was procedure-related morbidity in 1 patient. This patient suffered right-sided leg weakness after the procedure because of thrombo-embolism. The relatively lower rate of good outcome than initial good H-H grade resulted from hospital-acquired pneumonia and sepsis of 3 (33.3%) patients.

Predicting factors of clinical outcome

As mentioned above, we divided the patients into two groups; good (H-H grade 1-3) and poor (H-H grade 4 and 5) outcomes. We analyzed the clinical outcomes for the statistical significance according to variable factors, such as the presence of acute hy-

drocephalus, treatment modalities, H-H grade and age. It was reported that ruptured PICA aneurysms present a unique characteristic of intracranial aneurysms because of a higher incidence of intraventricular hemorrhage and secondary hydrocephalus compared with other intracranial aneurysms¹⁰. It was reported that EVD was performed prior to treatment of PICA aneurysm rupture using endovascular coiling in all patients¹³. Twelve (60%) of 20 patients had acute hydrocephalus at the initial presentation. According to the presence of acute hydrocephalus, there was statistical significance. All of seven patients with poor outcomes, they had the acute hydrocephalus. On the other hand, in 8 (61.5%) of 13 patients with good outcomes, they had no acute hydrocephalus. We immediately tried to perform EVD when a slight change of acute hydrocephalus was seen in CT findings. We tried to maintain EVD in the period of vasospasm and we determined the ventriculo-peritoneal shunt if intracranial pressure was increased and the patient showed the neurological deterioration after removal of EVD.

Since the first description of the H-H grade as the clinical grading system in 1968⁹, the patients with good H-H grades are thought to be a high potential for good outcomes, and patients with poor H-H grades are thought to be a high potential for poor outcomes. For ruptured PICA aneurysms, they also had the potential risk for clinical outcomes. In five (62.5%) of 8 patients with poor grades at the initial presentation, they had poor outcomes but in ten (83.3%) of 12 patients who had good grades, they had good outcomes. This factor showed the statistical significance in our study.

Another factor predicting the poor outcome was the patient's age at symptom presentation. Twelve (75%) of 16 patients below 70 years had good outcomes but 3 (75%) of 4 patients over 70 years had poor outcomes. The mean age of patients who had good outcomes was 52.9 ± 11.4 years ($n=13$) but that of patients with poor outcomes was 61.4 ± 11.9 years ($n=7$). Although this factor showed no statistical significance in our study, maybe because of the small series of patients with ruptured PICA aneurysms, a higher percentage of patients below 70 years showed the good clinical outcomes.

And so, in our study, the presence of acute hydrocephalus and poor H-H grade was correlated with poor outcomes. However, age and treatment modalities showed no statistical correlation of clinical outcomes. The summary of univariate analysis of GOS according to variable clinical characteristics was listed in Table 3. Unfortunately, our data had the limitations with no available multivariate analysis because of a small volume of the patients.

CONCLUSION

Our study results indicate that aggressive and early treatment may overcome the initial poor presentation despite higher inci-

dence of acute obstructive hydrocephalus and poor clinical presentation in the ruptured PICA aneurysms. Also, the statistical correlations was seen between initial poor H-H grade, the presence of acute hydrocephalus and clinical outcomes. Also, initial H-H grade and acute hydrocephalus may affect more on the clinical outcome than treatment modalities in the ruptured PICA aneurysms.

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