Do Characteristics of Dissection Differ between the Posterior Inferior Cerebellar Artery and the Vertebral Artery?

Juntaro Matsumoto, MD,* Toshiyasu Ogata, MD,*† Hiroshi Abe, MD,* Toshio Higashi, MD,* Koichi Takano, MD,‡ and Tooru Inoue, MD*

Objective: The purpose of this study was to clarify the features of posterior inferior cerebellar artery (PICA) dissection. *Materials and Methods:* We prospectively registered 93 consecutive patients and 108 arteries with confirmed diagnoses of dissection in the vertebral artery (VA) or PICA between February 2007 and January 2014. Patients were diagnosed with arterial dissection when they had both acute symptoms and radiological characteristics in magnetic resonance imaging or digital subtraction angiography. Patients were divided into 2 groups depending on whether the site of dissection was VA (VA group) or PICA (PICA group). We compared the clinical and radiological characteristics and clinical outcomes of PICA versus VA dissection. *Results:* Of the 93 patients included in this study, 83 were in the VA group, and 10 had arterial dissection in the PICA. Patients with PICA dissection more frequently suffered from SAH ($P < .001$), whereas nonstroke symptom was often the initial symptom in the VA group. Pearl sign was seen most frequently at the dissection site of PICA. Surgical or endovascular treatment was performed in 9 of 10 PICA dissections, whereas more than half of the VA dissections were treated conservatively ($P < .001$). SAH was significantly more severe in the patients with PICA dissection compared with those in the VA group ($P = .049$). *Conclusion:* Patients with PICA dissection suffered from subarachnoid hemorrhage more frequently than those with VA dissection. PICA dissection was treated with surgical intervention, whereas VA dissection was treated conservatively. **Key Words:** Posterior inferior cerebellar artery—vertebral artery—dissection.

Introduction

Arterial dissection in the vertebrobasilar system was reported to be frequently observed in the Asian population, with differences in the clinical features between dissections in the vertebrobasilar and carotid systems.[1] With respect to dissection in the vertebrobasilar system, there are several reports on the clinical and imaging findings and treatment of vertebral artery (VA) dissection.[2-4] However, there are a very few reports of dissection in the posterior inferior cerebellar artery (PICA).[5] As a result, the clinical features, imaging findings and the treatment of PICA dissection remain to be fully determined. Furthermore, although both VA and PICA belong to the vertebrobasilar system, there are no studies that report the differences between VA and PICA dissections. Thus, we compared the characteristics of clinical background, imaging findings, and outcome between PICA and VA dissections.

Materials and Methods

We prospectively registered 93 consecutive symptomatic patients with confirmed dissection in the VA or

From the *Department of Neurosurgery; †Department of Neurology; and ‡Department of Radiology, Faculty of Medicine, Fukuoka University, Japan.

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Address correspondence to Toshiyasu Ogata, MD, Department of Neurosurgery, Faculty of Medicine, Fukuoka University, 7-45-1 Nanakuma, Jonan-ku, Fukuoka 814-0180, Japan. E-mail: toshi.ogata1@gmail.com.

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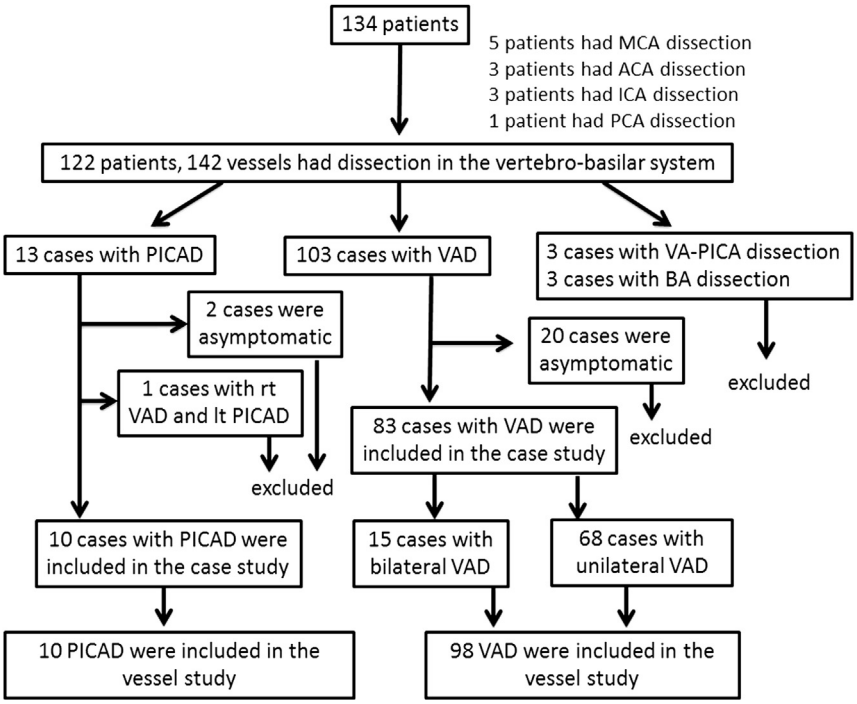

Figure 1. *Flow chart of patient selection.*

PICA between January 2007 and January 2014 (Fig 1). If a patient was suspected to have arterial dissection, he or she underwent magnetic resonance imaging (MRI) and digital subtraction angiography (DSA). All patients met the following inclusion criteria[6]: (1) a history of acute clinical symptoms and/or relevant dissection with either (2) angiographical evidence of arterial dissection such as pearl and string, tapering occlusion, intimal flap, and/or double lumen sign at DSA, or (3) the presence on standard MRI scans of areas exhibiting crescent-shaped high signal intensity within a vessel wall.

The patients were divided into two groups: patients with VA arterial dissection (VA group) and patients with PICA dissection (PICA group). We excluded 3 patients with dissection that extended from the VA to the PICA, and 1 patient with right VA and left PICA dissections.

The patients' clinical backgrounds were recorded. Patients' symptoms were categorized as subarachnoid hemorrhage (SAH), ischemic stroke, and nonstroke. Nonstroke was defined as acute onset of headache or vertigo and/or no symptom with relevant arterial dissection on imaging. Because 15 patients had arterial dissections in the bilateral vertebrobasilar system, morphological findings were evaluated vessel by vessel. Morphological findings defined by DSA were classified as pearl sign, string sign, or tapered occlusion and pearl and string sign.[6] Intimal flap and double lumen sign were also diagnosed with DSA. Crescent-shaped high signal intensity within a vessel wall, which indicates intramural hematoma, was detected using T1-weighted 3D turbo spin echo of MRI. The location of PICA dissection was recorded according to the classification of segments described by Lister et al.[7] Fisher's group and Hunt and Kosnik grade were determined in patients who suffered from SAH. Severe SAH was determined if they had Hunt and Kosnik grade of >4.

If necessary, we performed direct surgical or endovascular treatment for some patients. The treatment approach was determined based on the patients' clinical characteristics, underlying diseases, angiographical findings, and personal choices. Coil embolization was considered as the first treatment option for the patients with SAH caused by dissecting aneurysm at both VA and PICA, which agrees with previous reports.[4,8] If patients had a large dissecting VA aneurysm that involved the origin of the PICA or large dissecting PICA aneurysm, surgical trapping of the aneurysm and bypass surgery of the occipital artery (OA)-PICA was recommended. Aneurysm trapping was performed predominantly in the patients with dissecting aneurysm at the cortical segment of PICA. Stent placement was also considered if severe stenosis of the VA or proximal PICA existed on either side and/or ischemic stroke had progressed. Antithrombotic treatment was considered for the patients with ischemic stroke. In some patients with bilateral, severe VA dissections, bypass surgery of the superficial temporal artery to the superior cerebellar artery was planned. Outcomes were evaluated by the modified Rankin scale (mRS) at the time when patients were discharged from our hospital. Good outcome was defined as 0 or 1 of mRS at discharge.

We statistically analyzed whether there were differences between the PICA and VA groups in the clinical background, and the treatment methods and outcomes

Table 1. *Case summary of PICA dissection*

Case	Age	Gender	Side	Site	Stroke category	HT	DM	HLp	Smoke	Treatment	mRS
1	65	M	Lt	Anterior medullary segment	BI	−	−	+	+	OA-PICA + AN trapping	1
2	55	F	Rt	Tonsillomedullary segment	SAH	+	−	−	−	OA-PICA + AN trapping	5
3	32	M	Lt	Lateral medullary segment	SAH	−	−	−	−	OA-PICA + AN trapping	0
4	67	F	Lt	Cortical segment	SAH	−	−	−	−	AN trapping	1
5	89	F	Rt	Telovelotonsillar segment	SAH	+	+	+	−	OA-PICA + AN trapping	5
6	63	F	Lt	Tonsillomedullary segment	SAH	−	−	−	−	Coil embolization	2
7	75	F	Rt	Cortical segment	SAH	+	−	+	−	AN trapping	4
8	54	F	Rt	Cortical segment	SAH	−	−	−	−	conservative	6
9	50	F	Rt	Telovelotonsillar segment	SAH	+	−	−	−	OA-PICA + AN trapping	5
10	54	F	Rt	Lateral medullary segment	SAH	+	−	−	−	PAO by NBCA	5

Abbreviations: An, aneurysm; BI, brain infarction; DM, diabetes mellitus; HLp, hyperlipidemia; HT, hypertension; mRS, modified Rankin scale; NBCA, n butyl-2-cyanoacrylate; OA-PICA, occipital artery to posterior inferior cerebellar artery bypass surgery; PAO, proximal artery occlusion; PICA, posterior inferior cerebellar artery; SAH, subarachnoid hemorrhage.

at discharge. For comparison of imaging findings and treatment, the vessels with dissection were divided into PICA or VA groups. Fisher exact test was used for the analyses of categorical variables. Unpaired t-test or Mann-Whitney U-test was used for the analyses of continuous variables. SPSS v21 (IBM Co.) was used for statistical analyses. A *P*-value of less than .05 was considered significant.

Results

Ninety-three patients were registered in the current study. Of these, 83 belonged to the VA group and 10 had arterial dissection in the PICA. The summary of PICA dissection is shown in Table 1. A case with PICA dissection at the anterior medullary segment suffered from ischemic stroke, whereas all 9 cases with PICA dissection distal from the lateral medullary segment had SAH. The comparison of patients' background and clinical characteristics is shown in Table 2. Although there were no significant differences between the 2 groups in age, the frequency of hypertension, diabetes mellitus, hyperlipidemia, and alcohol intake. Female patients had PICA dissection significantly frequently ($P = .004$) and there were no patients with PICA dissection who had smoking habit ($P = .014$). The patients in the PICA group more frequently suffered from SAH, whereas nonstroke symptoms occurred most frequently in the VA group ($P < .001$). A summary of patients with SAH is shown in Table 3. Neither Hunt and Kosnik grade nor Fisher's group was different between the 2 groups.

With 15 patients having bilateral VA dissections, the numbers of vessels with PICA and VA dissections were 10 and 98, respectively. The imaging findings of these patients are shown in Table 4. DSA findings was significantly different between the 2 groups ($P = .03$); that is, pearl sign was observed frequently in PICA, whereas string sign or tapered occlusion was commonly seen in VA. MRI findings indicated that crescent-shaped high signal intensity within a vessel wall was seen in more than 60% of VA dissections, whereas MRI was obtained in only 1 PICA dissection. A summary of the treatments is shown in Table 5. The treatment method was significantly different between the VA and PICA dissections; that is, endovascular surgery only or conservative treatment only was frequently chosen in VA dissection, whereas PICA dissection was treated with OA-PICA bypass surgery in addition to surgical trapping of PICA. The rate of good functional outcome defined from 0 to 1 of mRS was significantly lower in the PICA group ($P = .001$, Table 2). Furthermore, mRS score was significantly more severe in the patients with PICA dissection who

Table 2. *Clinical characteristics of patients with VA and PICA dissection*

	VAD (n = 83)	PICA dissection (n = 10)	*P* value
Age	53.1 ± 12.6	60.4 ± 15.4	.095
Gender (male)	57 (68.7%)	2 (20.0%)	.004
Hypertension	52 (62.7%)	7 (70.0%)	.74
Hyperlipidemia	24 (28.9%)	2 (20.0%)	.72
Diabetes mellitus	10 (12.1%)	1 (10.0%)	1.00
Smoking	32 (38.6%)	0 (.0%)	.014
Alcohol	29 (34.9%)	1 (10.0%)	.16
Stroke category			
Nonstroke	42 (50.6%)	0 (.0%)	<.001
Ischemic stroke	29 (34.9%)	1 (10.0%)	
SAH	12 (14.5%)	9 (90.0%)	
mRS 0-1	70 (84.3%)	3 (30.0%)	.001

Abbreviations: mRS, modified Rankin scale; PICA, posterior inferior cerebellar artery; SAH, subarachnoid hemorrhage; VAD, vertebral artery dissection.

Table 3. *The comparison of severity, CT findings, and outcome between patients who suffered from SAH caused by VA and PICA dissections*

	VAD (n = 12)	PICA dissection (n = 9)	*P* value
H&K grade	4 (2-4)	4 (3-5)	.46
Severe SAH	7 (58.3%)	6 (66.7%)	1.00
Fisher group	4 (4-4)	4 (4-4)	.86
mRS	1 (1-4)	5 (2-5)	.049
mRS 0-1	7 (58.3%)	2 (22.2%)	.18

Abbreviations: H&K grade, Hunt and Kosnik grade; mRS, modified Rankin scale; PICA, posterior inferior cerebellar artery; SAH, subarachnoid hemorrhage; VAD, vertebral artery dissection.

suffered from SAH compared with those with VA ($P = .049$) (Table 3). However, other radiological findings and the rate of good outcome were not significantly different.

Discussion

Although the accurate incidence of PICA dissection has not been reported, PICA dissecting aneurysms account for around .5% of all intracranial aneurysms.[9] There are few case series reports of dissection and dissecting aneurysms, although these conditions are still considered rare.[5,8-11] Recent imaging advances have increased the ability to diagnose PICA dissection. For example, a recent observational study conducted in Japan indicated that approximately 6% of patients with cerebral artery dissection had PICA dissection.[12] No reports, however, have described differences between PICA and VA dissections. Therefore, we examined the differences in the clinical features, imaging findings, and outcomes between VA and PICA dissections.

Table 4. *Comparison of imaging in patients of VAD with that of PICA dissection*

	VAD (n = 98)	PICA dissection (n = 10)	*P* value
DSA performed	n = 98	n = 10	
Pearl sign	30 (30.6%)	5 (50.0%)	.03
String sign or occlusion	37 (37.8%)	0 (.0%)	
Pearl string sign	31 (31.6%)	5 (50.0%)	
Intimal flap	14 (14.3%)	0 (.0%)	.35
Double lumen	11 (11.2%)	0 (.0%)	.59
MRI performed	n = 90	n = 1	
Crescent-shaped high intensity	61	1	

Abbreviations: DSA, digital subtraction angiography; MRI, magnetic resonance imaging; PICA, posterior inferior cerebellar artery; SAH, subarachnoid hemorrhage; VAD, vertebral artery dissection.

We found that patients with PICA dissection more frequently suffered from stroke, especially SAH. Pearl sign, indicating aneurysmal dilatation, was also observed frequently in the PICA group compared with the VA group. Although it is well-known that VA dissection frequently induces SAH, we found that PICA dissection causes SAH more frequently for VA dissection. Our data also suggest that arterial dissection at the distal site of PICA is more likely to cause SAH than for ischemic stroke. MRI was not obtained in 9 of 10 patients with PICA dissection as they generally had poor general condition such as respiratory failure or seizures, and thus were unable to undergo MRI examination. DSA can be promptly performed when the patients' general condition is being diagnosed. DSA might be more appropriate compared with MRI for detecting PICA dissection, once PICA dissection is suspected.

Patients with PICA dissection more frequently underwent surgical trapping with OA-PICA bypass compared with those with VA dissection. As described previously, our policy was that endovascular surgery was first considered as the treatment option in patients with SAH. In our case series, however, SAH induced by dissecting aneurysms in the PICA was less frequently treated with endovascular coil embolization. Unlike endovascular coil embolization for dissection of the VA, which has a contralateral VA, PICA can cause ischemic stroke in patients with poor collateral circulation to the PICA territory. In our case series, therefore, surgical trapping or OA-PICA bypass surgery was performed more frequently in the PICA group than in the VA group. It has been reported that unless medullary infarction occurs, the outcome is relatively good in patients who undergo surgical trapping in addition to OA-PICA bypass surgery.[13] Coil embolization for dissecting aneurysm in the PICA has also been reported to be relatively safe.[14] To clarify whether endovascular treatment or surgical trapping and OA-PICA bypass surgery is a better treatment option for patients with dissecting aneurysm in PICA, randomized controlled trials and/or large observational studies are required.

There are some limitations of the current study. Despite our 6-year registration, this is a single-center study; as a result, the number of patients included was still small. Another potential limitation is that not all of the patients underwent MRI, particularly those with SAH. Because patients' general condition was sometimes not good enough to undergo MRI, the evidence of the dissection of PICA might be difficult to be confirmed. Furthermore, with regard to the outcome of the patients with SAH, mRS score increased in PICA dissection, although other radiological findings and the rate of good outcome were not significantly different. Further studies are needed to

Table 5. *The differences of treatment by vessel between VA and PICA dissections*

	VAD (n = 98)	PICA dissection (n = 10)	*P* value
Treatment			
Endovascular surgery only	25 (25.5%)	2 (20.0%)	<.001
Surgical trapping only	0 (.0%)	2 (20.0%)	
OA-PICA + trapping	6 (6.1%)	5 (50.0%)	
OA-PICA + coil embolization	2 (2.0%)	0 (.0%)	
STA-SCA bypass surgery	5 (5.1%)	0 (.0%)	
Medical treatment only	60 (61.2%)	1 (10.0%)	

Abbreviations: OA-PICA + coil embolization, bypass surgery of occipital artery to posterior inferior cerebellar artery in addition to coil embolization; OA-PICA + trapping, bypass surgery of occipital artery to posterior inferior cerebellar artery in addition to surgical trapping of PICA; STA-SCA, bypass surgery of superficial temporal artery to superior cerebellar artery; VAD, vertebral artery dissection.

confirm whether the outcome was different in SAH induced by PICA versus VA dissection.

Conclusion

Patients with PICA dissection more frequently suffered from SAH, whereas nonstroke symptoms were often observed in patients with VA dissection. The more distal the dissection sites in PICA, the more frequent the incidence of aneurysmal dilatation, which resulted in SAH. Patients with PICA dissection more frequently underwent surgical trapping in addition to OA-PICA bypass surgery than those with VA dissection.

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