Clinical Outcome and Prognostic Factors After Internal Coil Trapping of Ruptured Vertebral Artery Dissection

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Introduction

Internal coil trapping is one of the treatment options used to prevent rebleeding from a ruptured intracranial vertebral artery dissection (VAD). Postoperative medullary infarctions have been reported as one of the complications of this treatment strategy. The aim of this study is to determine the relationship between a postoperative medullary infarction and the clinical outcomes for patients with ruptured VADs treated with internal coil trapping during the acute stage of a subarachnoid hemorrhage (SAH).

Methods

A retrospective study identified 38 patients, who presented from 2006 to 2011 with ruptured VADs and underwent internal coil trapping during the acute stage of a SAH. The SAH was identified by computed tomography, and the diagnosis for VADs was rendered by cerebral angiography. Under general anesthesia, the dissection was packed with coils, beginning at the distal end and proceeding proximally. When VAD involved the origin of the posterior inferior cerebellar artery (PICA) with a large cerebellar territory, an occipital artery (OA)-PICA anastomosis was created prior to internal coil trapping. Pre- and postoperative radiological findings, clinical course and outcomes were analyzed.

Results

The internal coil trapping was completed within 24 hours after admission. The OA-PICA anastomosis followed by the internal coil trapping was performed in 5 cases. Postoperative rebleeding did not occur in any of the cases during a mean follow-up period of 16 months. The postoperative MRIs showed medullary infarctions in 18 patients (47%) (Table 1). The topographical pattern of medullary infarctions, which was determined using the schemes from previous reports [1,2,3], included 7 (38.9%) dorsolateral infarctions, 5 (27.8%) large inferodorsolateral infarctions, 3 (16.7%) hemimedullary infarctions, 2 (11.1%) paramedian infarctions, and 1 (5.6%) dorsal infarction (Figure 1). The mean length of the trapped VAD for the infarction group (15.7 ± 6.0 mm) was significantly longer than that of the non-infarction group (11.5 ± 4.3 mm) (p=0.019). Three of the 5 cases treated with OA-PICA anastomosis were associated with postoperative medullary infarction. The clinical outcomes at 6 months were favorable (mRS 0-2) for 23 (60.5%) patients and unfavorable (mRS 3-6) for 15 (39.5%) patients (Table 2). Of the 18 patients with postoperative medullary infarctions, the outcomes were favorable for 6 (33.3%) and unfavorable for 12 (66.7%) patients (Table 3). The large infarctions, especially hemimedullary and inferodorsolateral infarctions, usually caused unfavorable outcomes. A logistic regression analysis predicted the following independent risk factors for unfavorable outcomes: postoperative medullary infarctions (odds ratio [OR] 21.287; 95% confidence interval [CI] 2.622-498.242; p=0.003); preoperative rebleeding episodes (OR 7.450; 95% CI 1.140-71.138; p=0.036); and a history of diabetes mellitus (OR 45.456; 95% CI 1.993-5287.595; p=0.013).

Table.1

Risk factors for medullary infarction following endovascular trapping of the ruptured vertebral artery dissection

Variables	Infarction group (n=18)	Non-infarction group (n=20)	P, Univariate
Age, mean ± SD	56 ± 9	50 ± 14	0.036*
Male (n=19)	12 (63%)	7 (37%)	0.103
Right side (n=27)	12 (44%)	15 (56%)	0.724
WFNS grade 1 or 2 (n=19)	8 (42%)	11 (58%)	0.746
Preoperative rebleeding (n=15)	10 (67%)	5 (33%)	0.096
Length of the trapped VAD, mean ± SD, mm	15.7 ± 6.0	11.5 ± 4.3	0.019*
Length to vertebrobasilar junction, mean ± SD, mm	10.9 ± 4.8	9.9 ± 4.3	0.45*
VAD location			
Proximal to PICA (n=7)	3 (43%)	4 (57%)	1.000
Distal to PICA (n=14)	6 (43%)	8 (57%)	0.745
Absence of PICA (n=8)	5 (63%)	3 (37%)	0.438
PICA involvement (n=9)	4 (44%)	5 (56%)	1.000
OA-PICA bypass (n=5)	3 (60%)	2 (40%)	0.653

P indicates difference between subgroups by Fisher exact test or Mann-Whitney test.
*Mann-Whitney U test
H&K grade indicates Hunt and Kosnik grade; VAD, vertebral artery dissection; PICA, posterior inferior cerebellar artery; OA, occipital artery

Table.2

Predictors of clinical outcome for ruptured vertebral artery dissection treated by endovascular trapping

Variables	Favorable Outcome mRS 0-2 (n=23)	Unfavorable Outcome mRS 3-6 (n=15)	P, Univariate	P, Regression (OR, 95% CI)
Age				
mean ± SD	50 ± 12	57 ± 10	0.034*	0.759 (1.015, 0.920-1.119)
Male (n=19)	10 (43%)	9 (60%)	0.508	0.795 (1.334, 0.136-12.261)
Right side (n=27)	16 (70%)	11 (73%)	1.000	
Past history				
Hypertension (n=19)	13 (57%)	6 (40%)	0.507	
Diabetes mellitus type 2 (n=5)	1 (4%)	4 (27%)	0.069	0.013 (45.456, 1.993-5287.595)
Hyperlipidemia (n=5)	2 (9%)	3 (20%)	0.365	
WFNS grade 4 or 5 (n=19)	9 (39%)	10 (66.7%)	0.184	
Preoperative rebleeding (n=15)	5 (22%)	10 (67%)	0.008	0.036 (7.450, 1.140-71.138)
Medullary infarction (n=18)	6 (26%)	12 (80%)	0.002	0.003 (21.287, 2.622-498.242)
Shunt for hydrocephalus (n=10)	7 (30%)	3 (20%)	0.709	
Symptomatic vasospasm (n=2)	0 (0%)	2 (13%)	0.149	
PICA involvement (n=9)	6 (26%)	3 (20%)	1.000	
OA-PICA bypass (n=7)	5 (22%)	2 (13%)	0.681	

P indicates difference between subgroups by Fisher exact test or Mann-Whitney test.
*Mann-Whitney U test
WFNS, World Federation of Neurological Surgeons; PICA, posterior inferior cerebellar artery; OA, occipital artery

Table.3

Characteristics of patients with postoperative medullary infarction

No.	Age	Sex	Side	WFNS	Rebleeding	Angiography	VAD location	Treatment	PICA sacrifice	VPS	Symptomatic VS	Nature of medullary infarction	Final mRS	Morbidity and mortality at 6 months
1	45	F	R	1	yes	pearl and string	proximal to PICA	trapping	no	no	no	large inferodorsolateral	4	aspiration pneumonia
2	61	M	R	5	yes	pearl and string	absence of PICA	trapping	no	no	no	hemimedullary	5	persistent disturbance of consciousness, tetraparesis
3	66	M	R	1	no	pearl	absence of PICA	trapping	no	yes	no	mild left hemispasm, mild sensory disturbance	1	
4	49	F	R	1	no	pearl	absence of PICA	trapping	no	yes	no	paramedian	3	small medullary infarction
5	61	F	L	4	no	pearl	distal to PICA	trapping	no	no	no	dorsolateral	5	brain death caused by second SAH (ruptured MCA dissection)
6	59	M	R	5	yes	pearl and string	absence of PICA	trapping	no	yes	no	large inferodorsolateral	4	aspiration pneumonia
7	52	M	L	2	yes	pearl and string	absence of PICA	trapping	no	no	no	dorsolateral	4	right hemiparesis and sensory adminstered by VS
8	53	M	R	5	yes	pearl	proximal to PICA	trapping	no	yes	yes	dorsolateral	4	persistent disturbance of consciousness, tetraparesis
9	42	M	L	2	no	pearl and string	absence of PICA	trapping	no	yes	no	paramedian	4	muscle weakness
10	66	F	L	1	no	pearl	distal to PICA	trapping	no	no	no	hemimedullary	4	aspiration pneumonia
11	56	M	R	5	no	pearl and string	distal to PICA	trapping	no	yes	no	large inferodorsolateral	4	right moderate mono, left weakness
12	53	F	R	1	no	pearl and string	PICA involvement	bypass+trapping	no	yes	yes	dorsolateral	3	mild ataxia
13	77	M	R	4	yes	pearl and string	distal to PICA	trapping	no	yes	no	dorsolateral	5	persistent disturbance of consciousness, tetraparesis
14	51	M	R	4	no	pearl	proximal to PICA	trapping	no	no	no	large inferodorsolateral	3	right mono-hemiparesis, dysphasia
15	48	M	L	1	no	pearl	distal to PICA	trapping	no	no	yes	dorsolateral	4	left hemianopsia
16	60	M	L	1	no	pearl	absence of PICA	trapping	no	no	no	dorsal	1	mild left ataxia, right sensory disturbance
17	61	F	R	3	no	pearl	PICA involvement	bypass+trapping	no	no	no	hemimedullary	3	acute respiratory problem
18	55	M	L	2	no	pearl	distal to PICA	trapping	no	no	no	paramedian	4	right hemispasm, dysphasia

F, female; M, male; R, right; L, left; WFNS, world federation of neurological surgeons scale; VAD, vertebral artery dissection; PICA, posterior inferior cerebellar artery; VPS, ventriculoperitoneal shunt; VS, vasospasm; mRS, modified Rankin scale; MCA, middle cerebral artery

Figure.1

Postoperative MRI of the representative cases with medullary infarction. A: hemimedullary, B: large inferodorsolateral, C: paramedian, D: dorsolateral, E: dorsal (arrow head)

References

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Conclusions

A postoperative medullary infarction was associated with unfavorable outcomes after internal coil trapping for ruptured VADs. Coil occlusion of the long segment of vertebral artery led to medullary infarction, and OA-PICA bypass did not prevent medullary infarction. A vertebral artery sparing procedure such as flow diversion by stent is an alternative treatment in the future, if this approach is demonstrated to effectively prevent rebleeding.