CASE REPORT

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TREATMENT OF A CEREBRAL DISSECTING ANEURYSM IN ANTERIOR CIRCULATION: REPORT OF 11 SUBARACHNOID HEMORRHAGE CASES

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ABSTRACT

This report presents 8 cases of internal carotid artery aneurysms, 1 case of a middle cerebral artery aneurysm, and 2 cases of anterior cerebral artery aneurysms, together with a discussion of the treatment of aneurysms in anterior circulation. All cases showed subarachnoid hemorrhage. Two of the 8 internal carotid artery aneurysms were trapped with a low-flow bypass; however, both patients died of an immediate hemodynamic infarction or vasospasm-induced infarction. Five of the 8 internal carotid artery aneurysms were trapped after revascularization with high flow bypass. Four of those patients were self-supporting at discharge, but one patient was discharged in a vegetative state due to the sacrifice of arterial branches which were included in the dissecting portion. One case of the dissecting aneurysm in the M2 portion of the middle cerebral artery was trapped after low-flow bypass. This patient was self-supporting at discharge. In 2 cases of anterior cerebral artery aneurysms, the lesions were first wrapped with Bemsheets, and then the aneurysmal clip was applied on the wrapped dome. Trapping following high-flow bypass is the best method for treating a dissecting aneurysm in the internal carotid artery. Trapping also can be used to treat a dissecting aneurysm of the middle cerebral artery, after low-flow bypass. Clipping on the wrapped aneurysm can also be performed successfully in the anterior cerebral artery aneurysm.

Key Words: Dissecting aneurysm, Internal carotid artery, Anterior and middle cerebral artery, Clipping on wrapping, Bypass surgery

INTRODUCTION

It is very difficult to treat a dissecting aneurysm.[1-5] This is because complex vascular reconstruction is frequently necessary when the aneurysm is trapped. If vascular reconstruction is difficult, clipping on the wrapped aneurysm should be performed to preserve the arterial trunk. Eleven cases of ruptured aneurysm in anterior circulation required operation in addition to vascular reconstruction over the past three years. This report presents those cases and focuses on operative strategy.

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PATIENTS AND METHODS

We analyzed 185 cases of subarachnoid hemorrhage from October 1, 2007 to October 30, 2010. The location of aneurysms were internal carotid artery in 60 cases, anterior cerebral artery in 65 cases, middle cerebral artery in 37 cases, and posterior circulation in 23 cases. Ten cases were dissecting aneurysms of the vertebral artery. The procedures performed were operation in 126 cases, coil embolization in 49 cases, and medicinal treatment in 10 cases.

We experienced 11 cases of dissecting aneurysm in the anterior circulation during the same period (Table 1). All cases showed a subarachnoid hemorrhage from a ruptured aneurysm. Eight of the cases had lesions located in the internal carotid artery (Case 1–8); one was positioned in the middle cerebral artery (Case 9), and 2 were located in the anterior cerebral artery (Cases 10–11). One aneurysm was an unruptured dissecting aneurysm of the anterior cerebral artery associated with a ruptured saccular aneurysm of the opposite anterior cerebral artery (Case 11).

Surgical or endovascular treatment was performed on the same day as the onset in 5 cases (Cases 1,4,7,9,10), the day after the onset in 4 cases (Cases 2,5,6,11), 2 days after the onset in one case (Case 3), and 53 days after the onset in one case (Case 8). The last case had already accepted endovascular treatment in another hospital on the same day as the onset, and 10 days after the onset. The dissection was mainly diagnosed on the basis of intraoperative findings of a red thin arterial wall, with (Cases 1,3,4,5,6,7,9) or without (Cases 10,11) an intramural thrombus, which was often lacerated during the procedure. As for the aneurysm treated with endovascular trapping, the diagnosis was made based on the angiographical findings of aneurysmal outpouching (Case 2), or a blister-like appearance (Case 8) in the non-branching site, which represent the dissecting aneurysms. Magnetic resonance imaging (T1-weighted image) was taken one day after the onset in Case 3, but it did not show the intramural hematoma characteristic of a dissecting aneurysm.

As for the background of the patients, 6 cases (Cases 1,2,3,5,6,9) had a past history of hypertension, and 3 cases (Cases 4,5,7) imbibed alcohol every day.

RESULTS

Dissecting aneurysm of internal carotid artery (8 cases)

Trapping of the aneurysm following a low-flow bypass (superficial temporal artery-middle cerebral artery double anastomosis) was performed in two cases (Cases 1,2). However, both cases died of immediate hemodynamic infarction or vasospasm–induced infarction.

In 5 cases, the aneurysms were trapped after revascularization with high-flow bypass (radial arterial graft in Cases 3 and 4 and vein graft in Cases 5, 6 and 7). Case 3 suffered from cerebral infarction in the right frontal lobe following the occlusion of graft. In 3 cases (Cases 3,5,6), the posterior communicating artery, anterior choroidal artery, and perforating artery of the internal carotid artery were included in the dissecting portion. These arteries were sacrificed, and the cerebral infarction occurred in the internal capsule, basal ganglia, and medial temporal lobe. Four cases (Cases 3,4,5,7) were self-supporting at discharge and one case (Case 6) was discharged in a vegetative state.

Case 8 was treated with endovascular obliteration of the aneurysm when she suffered a subarachnoid hemorrhage. Coil embolizations of the aneurysm were performed twice in the chronic stage following the coil compaction. As the cross-flow via the anterior and posterior communicating artery was sufficient, endovascular trapping of the internal carotid artery was conducted for the 3rd recurrence of the aneurysm.

Table 1 Summary of the cases
Abbreviations: ICA, internal carotid artery; MCA, middle cerebral artery; ACA, anterior cerebral artery; F, female; M, male; H&K, Hunt and Kosnic; C, internal carotid artery; M, middle cerebral artery; A, anterior cerebral artery; R, right; L, left; STA, superficial temporal artery; mRS, modified Rankin Scale.

	case						treatment	
	number	age	gender	H&K grade	location of aneurysm	laterality of aneurysm	vascular reconstruction	procedure for the aneurysm
ICA								
	1	62	F	5	C1-2	R	emergent STA-MCA single anastomosis after trapping	surgical trapping on day 0
	2	65	F	3	C2	L	STA-MCA double anastomosis	rebleeding after coil embolization. Endovascular trapping was performed on day 4
	3	44	M	4	C1-2	R	high-flow bypass with radial arterial graft	surgical trapping on day 2
	4	61	F	2	C1	L	high-flow bypass with radial arterial graft	enlargement of aneurysm after neck clipping. The aneurysm was trapped surgically on day 30.
	5	45	M	3	C2	R	high-flow bypass with saphenous vein graft	enlargement of aneurysm after neck clipping. The aneurysm was trapped surgically on day 42.
	6	67	M	4	C1-2	R	high-flow bypass with saphenous vein graft	surgical trapping on day 1
	7	74	M	2	C1-2	L	high-flow bypass with saphenous vein graft	surgical trapping on day 0
	8	40	F	3	C2	R	none	coil compaction happened 3 times after coil embolization of the dome. Endovascular trapping was performed on day 53 nevertheless.
MCA								
	9	70	F	2	M2 (superior trunk)	L	STA-MCA double anastomosis	surgical trapping on day 0
ACA								
	10	39	F	3	A2	L	anterior cerebral artery remained patent.	clipping on wrapped aneurysm on day 0
	11	75	F	3	A3	L	anterior cerebral artery remained patent.	clipping on wrapped aneurysm on day 1

	case	result		
		vascular insult		neurological status
	number	affected vessel	location of infarction	mRS at discharge
ICA				
	1	widespread ischemia in right anterior and middle cerebral arterial region	widespread infarction in the right cerebral hemisphere	6
	2	vasospasm of left anterior and middle cerebral arteries	widespread infarction in the left cerebral hemisphere	6
	3	occlusion of right posterior communicating artery and radial arterial graft	right frontal lobe, medial temporal lobe and right internal capsule	1
	4	branch of left operculofrontal artery	left frontal lobe	2
	5	perforating artery of right ICA	right internal capsule	2
	6	right posterior communicating artery and anterior choroidal artery	right internal capsule and basal ganglia	5
	7	none	none	0
	8	none	none	0
MCA				
	9	left lenticulostriate artery	left basal ganglia and corona radiata	2
ACA				
	10	none	none	0
	11	none	none	1

Representative Case 2

A 65-year-old female succumbed to a subarachnoid hemorrhage (Hunt and Kosnic Grade 3). Conventional angiography on day 1 revealed a non-branching aneurysm on the anterior wall of the left internal carotid artery (Fig. 1A). Coil embolization of the aneurysmal dome was performed.

Rebleeding occurred on day 4, although coil compaction was not found by angiography. Under the diagnosis of dissecting aneurysm, internal trapping was performed following superficial

Fig. 1 Case 2

A: Left carotid angiography on day 1, right anterior oblique view, revealing a dissecting aneurysm of the anterior wall of left internal carotid artery.

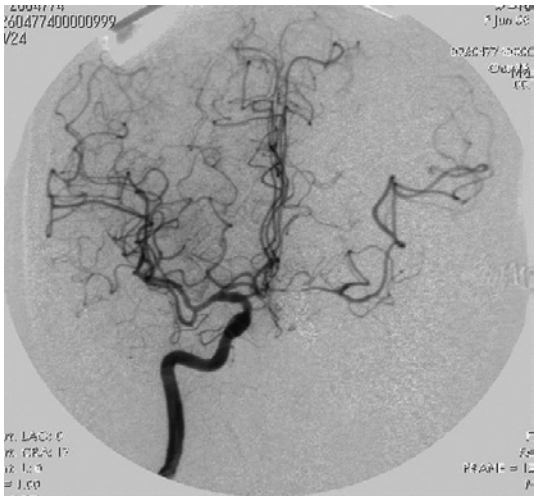

Fig. 1 Case 2

B: Postoperative right carotid angiogram on day 4 after the left superficial temporal artery-middle cerebral artery double anastomosis, and internal trapping of left internal carotid artery, A-P view. Although it showed good vascularization of the left cerebral hemisphere through the anterior communicating artery, vasospasm was seen in anterior and middle cerebral arteries.

temporal artery-middle cerebral artery double anastomosis. Postoperative angiography showed good vascularization of the left cerebral hemisphere through the anterior communicating artery and the superficial temporal artery-middle cerebral artery bypass (Fig. 1B,C). The postoperative course was uneventful, however, widespread left cerebral infarction was caused by a vasospasm on day 7 (Fig. 1D). In spite of barbiturate therapy, she died on day 9.

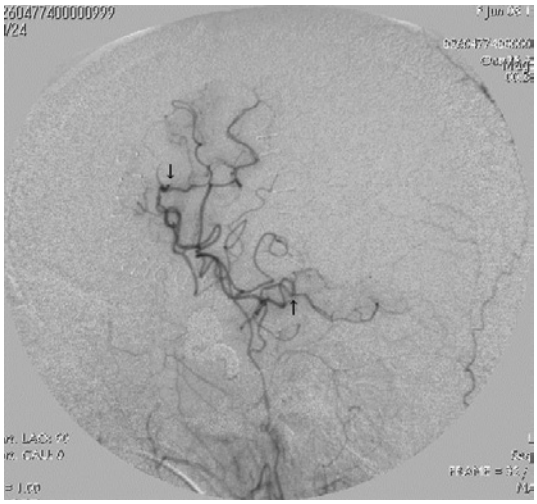

Fig. 1 Case 2
C: Postoperative left external carotid angiogram on day 4, after the left superficial temporal artery-middle cerebral artery double anastomosis and the internal trapping of left internal carotid artery. It showed good vascularization of the left cerebral hemisphere through the left superficial temporal artery-middle cerebral artery bypass (arrow).

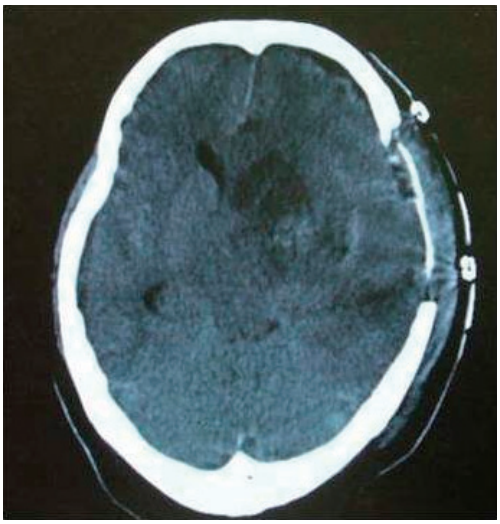

Fig. 1 Case 2
D: CT scan on day 7. Widespread left cerebral infarction was found.

Representative Case 5

A 45-year-old male suffered from a subarachnoid hemorrhage with an intracerebral hematoma in the right frontal lobe (Hunt and Kosnic Grade 3). Angiography showed a non-branching aneurysm in the C2 portion of the right internal carotid artery (Fig. 2A). Operation was performed on day 1. The vascular wall of the internal carotid artery was red-colored and thin, with an intramural thrombus (Fig. 2B). The aneurysmal neck, which was located proximal to the posterior communicating artery, was clipped. A small infarction occurred in the right internal capsule after

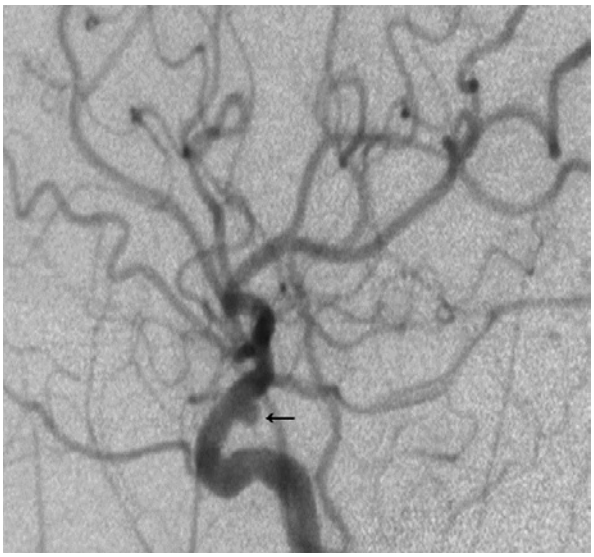

Fig. 2 Case 5

A: Right carotid angiography on admission, lateral view. It showed non-branching aneurysm (arrow) in C2 portion of the right internal carotid artery.

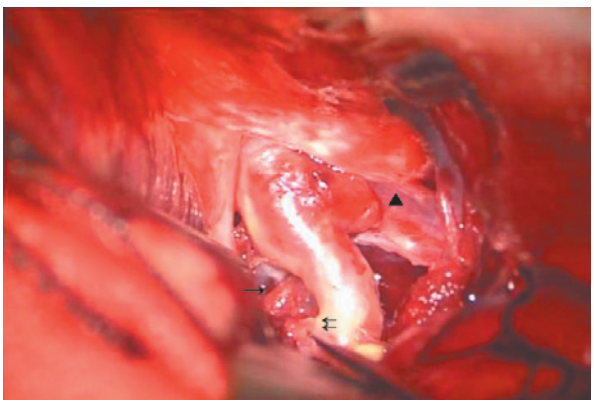

Fig. 2 Case 5

B: Intraoperative view before clipping. Vascular wall of internal carotid artery was red-colored and thin with intramural thrombus. The aneurysm (arrow head) projected postero-laterally. Posterior communicating artery (arrow) and anterior choroidal artery (double arrow) were observed in medial side of right internal carotid artery. Aneurysmal neck was located proximal to posterior communicating artery.

the operation, and the patient suffered from left hemiparesis.

The patient exhibited postoperative rebleeding on day 15. Cerebral angiography showed the regrowth of the aneurysm and the dislocation of the aneurysmal clip, which was applied parallel to the internal carotid artery. Trapping of the aneurysm following right superficial temporal artery-middle cerebral artery double anastomosis was scheduled, but we feared that the cerebral infarction would occur due to the vasospasm. Therefore, reconstruction of the aneurysmal neck was performed only with an aneurysmal clip, preserving the flow through the internal carotid artery.

Follow-up angiography on day 38 showed a recurrence of the aneurysm (Fig. 2C). Under the

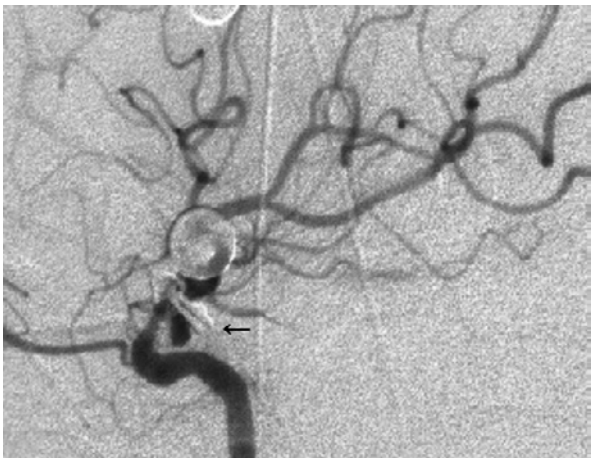

Fig. 2 Case 5
C: Follow-up right carotid angiography on day 38, lateral view, showing recurrence of aneurysm and dislocation of aneurysmal clip (arrow). Dissecting aneurysm was confirmed.

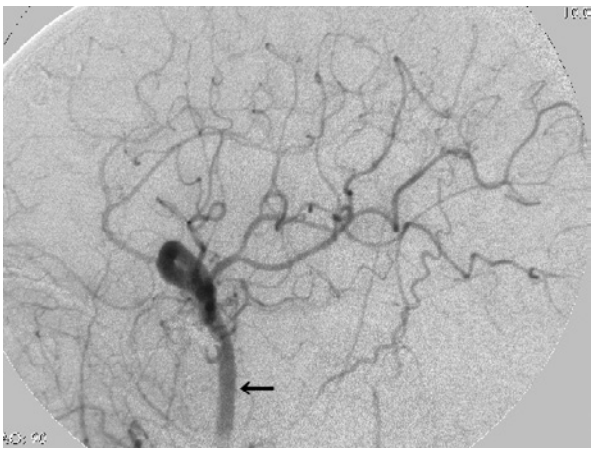

Fig. 2 Case 5
D: Right carotid angiography after high-flow bypass (saphenous vein graft between external carotid artery and M2 portion) and trapping of the internal carotid artery, lateral view. The right cerebral hemisphere was well revascularized through the bypass graft (arrow).

definite diagnosis of dissecting aneurysm, the trapping of the internal carotid artery was conducted on day 42, following a high-flow bypass (saphenous vein graft between external carotid artery and M2 portion) (Fig. 2D). The left hemiparesis improved later, and the patient was discharged in the condition of modified Rankin Scale 2 on day 66.

Dissecting aneurysm of middle cerebral artery (Case 9)

A 70-year-old female presented with subarachnoid hemorrhage (Hunt and Kosnic Grade 2). Also, hematoma was found in the left sylvian fissure. Because stenosis was found in the superior

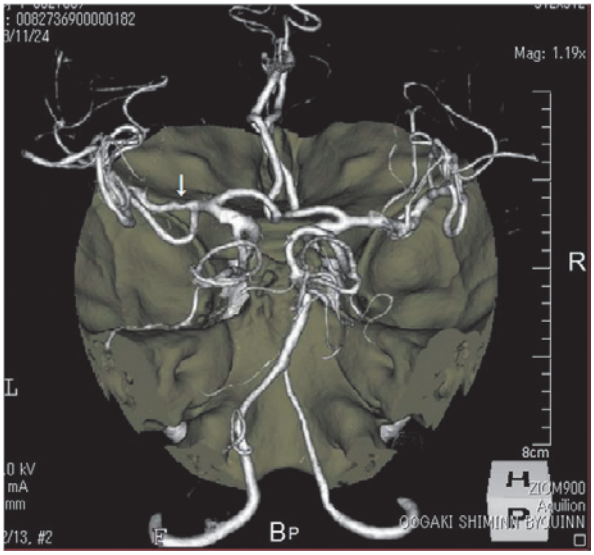

Fig. 3 Case 9

A: Three-dimensional CT angiography on admission. Because stenosis (arrow) was found in the superior trunk of the left middle cerebral artery, dissecting aneurysm was strongly suspected.

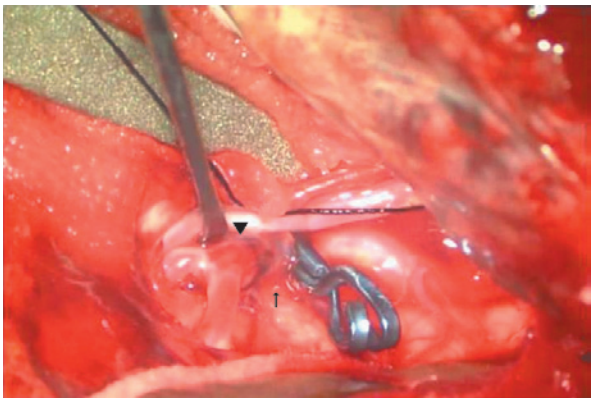

Fig. 3 Case 9

B: Intraoperative view. Intramural thrombus and thin red-colored arterial wall, suggesting arterial dissection (arrow head), was found in the superior trunk of the left middle cerebral artery. The perforating artery (arrow) originating from the dissecting portion was sacrificed. The proximal clip for trapping is shown.

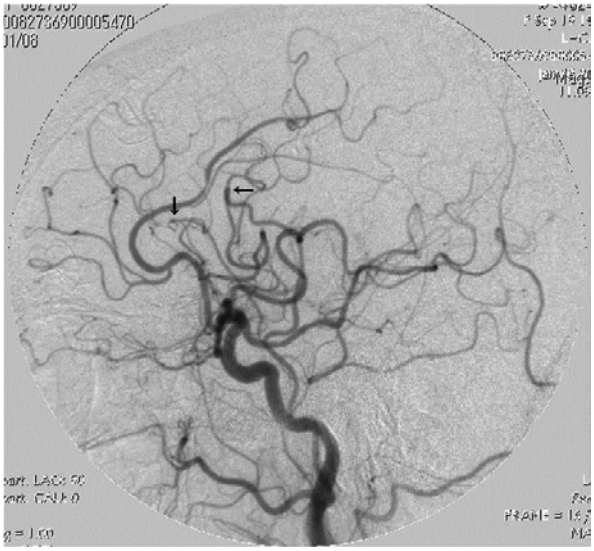

Fig. 3 Case 9
C: Left carotid angiogram after left superficial temporal artery-middle cerebral artery double anastomosis, and trapping of the aneurysm were performed, lateral view. It showed the well-revascularized superior trunk via the superficial temporal artery (arrow).

trunk of the left middle cerebral artery, dissecting aneurysm was highly suspected (Fig. 3A). The operation was performed on day 0, and the intramural thrombus and thin red-colored arterial wall, suggesting arterial dissection, were found in the superior trunk of the left middle cerebral artery (Fig. 3B). The trapping of the aneurysm was performed after left superficial temporal artery-middle cerebral artery double anastomosis. The perforating artery in the dissecting portion was sacrificed, and cerebral infarctions occurred in the left basal ganglia and corona radiata. Cerebral angiogram showed the well-revascularized superior trunk via the superficial temporal arteries (Fig. 3C). Although the patient suffered from mild aphasia and right hemiparesis, she recovered later and was discharged in the condition of modified Rankin Scale 2 on day 56.

Dissecting aneurysm of anterior cerebral artery (2 cases)

One patient (Case 10) had a ruptured dissecting aneurysm, and another patient (Case 11) had an unruptured dissecting aneurysm associated with a ruptured saccular aneurysm of the opposite anterior cerebral artery. Although an intramural thrombus was not found, the dissection was diagnosed based on the intraoperative findings of red thin arterial and aneurysmal walls in both cases. The lesions were first wrapped with Bemsheets, and the aneurysmal clip was applied on the wrapped dome in both cases. The postoperative course was uneventful, and both patients were discharged in good condition.

Representative Case 10

A 39-year-old female presented with subarachnoid hemorrhage (Hunt and Kosnic Grade 3). Three-dimensional CT angiography revealed aneurysmal dilatation at the A2 portion of the left anterior cerebral artery (Fig. 4A). The operation was performed on day 0, and a thin-walled non-branching aneurysm was found (Fig. 4B). The lesion was first wrapped with Bemsheets, and

then an aneurysmal clip was applied on the wrapped dome (Fig. 4C). The postoperative course was uneventful, and the aneurysm disappeared, according to the angiography which followed. The patient was discharged in the condition of modified Rankin Scale 0 on day 25.

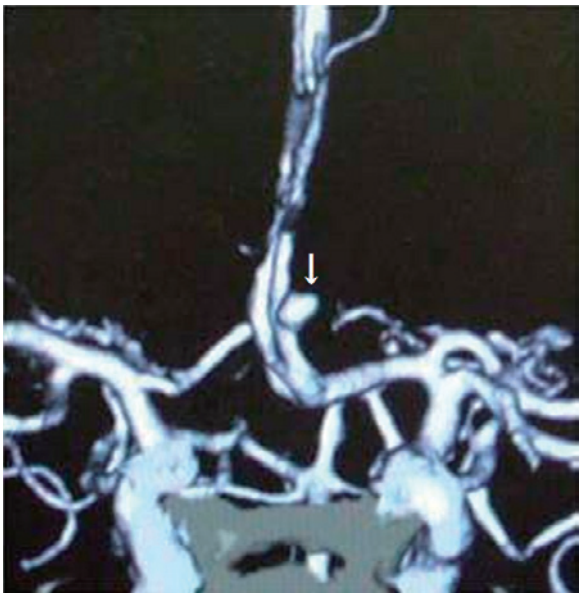

Fig. 4 Case 10
A: Three-dimensional CT angiography on admission, revealing aneurysmal dilatation (arrow) at A2 portion of left anterior cerebral artery.

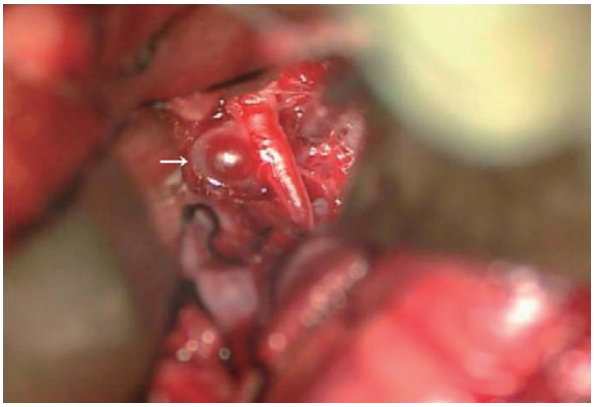

Fig. 4 Case 10
B: Intraoperative view before clipping. The red thin-walled, non-branching aneurysm (arrow) was found.

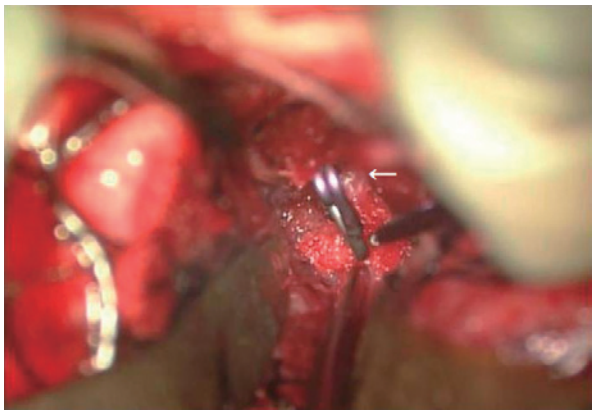

Fig. 4 Case 10
C: Intraoperative view after clipping. The lesion was wrapped with Bemsheets at first, and aneurysmal clip was applied on the wrapped dome, preserving left anterior cerebral artery (arrow).

DISCUSSION

Dissecting aneurysms were found in various arteries, and the percentage of their distribution was reported to be 4.4% in the internal carotid artery, 7.4% in the middle cerebral artery, 5.9% in the anterior cerebral artery, 51.4% in the vertebral artery, and 1.5% in the posterior inferior cerebellar artery.[6-9] In the current series of subarachnoid hemorrhage, dissecting aneurysms were revealed in 13.3% of internal carotid arteries, in 2.7% of middle cerebral arteries, and in 3.1% of anterior cerebral arteries. In the middle cerebral artery, dissecting aneurysms occurred at M1 in 52% of cases, M2 in 35% of cases, and M3 in 13% of cases.[10] As for the anterior cerebral artery, dissecting aneurysms were identified at A1 in 22% of cases, A2 in 69% of cases, A3 in 6% of cases, and A4 in 3% of cases.[10] The multiple dissecting aneurysms were also reported in anterior and middle cerebral arteries and the vertebral artery.[10-12]

The major symptoms of the dissecting aneurysm are hemorrhage and ischemia. In the aneurysm of the middle cerebral artery, 43% of the symptoms were hemorrhage, and 57% were ischemia.[10] As for the aneurysm of the anterior cerebral artery, 31% of the symptoms were hemorrhage, 55% were ischemia, and 14% of patients had both.[10] Although the simultaneous occurrence of subarachnoid hemorrhage and cerebral infarction is extremely rare, such cases have been reported in the dissection of anterior and middle cerebral arteries.[13-15]

Once the hemorrhage occurs, the dissecting aneurysm very easily rebleeds. Especially in the internal carotid artery, rebleeding before admission was demonstrated in 72% of patients, and intraoperative bleeding was exhibited in half of the patients who underwent surgery during the acute stage.[16] Therefore, it may be better to strictly regulate the patient's blood pressure without anticoagulation or antiplatelet therapy.[17] To avoid fatal rebleeding, surgical or intravascular treatment should be considered.[10,18-22]

In the case of a subarachnoid hemorrhage derived from a dissecting aneurysm of the internal carotid artery, tangential clipping with circumferential wrapping might achieve stabilization of the dissected artery without sacrificing the artery.[22] However, this procedure is problematic because of aneurysmal recurrence and rebleeding.[23] Postoperative growth of an aneurysm bulge or recurrent subarachnoid hemorrhage was reportedly seen in 50–66% of patients who had undergone wrapping or clipping of the aneurysm bulge in the acute phase.[16,19,24,25] Therefore,

trapping the aneurysm with a vascular reconstruction is recommended.[24] Low-flow bypass is dangerous even if the cross-flow via anterior or posterior communicating arteries is sufficient. Once the vasospasm occurs, the collateral flow becomes scarce easily, as shown in current Case 2. When the collateral flow is verified to be adequate, endovascular trapping of the aneurysm can be successfully performed in the chronic stage, as shown in current Case 8.

In the case of a ruptured dissecting aneurysm of the middle cerebral artery, the operation consists of wrapping, clipping, clipping on the wrapped aneurysm, and trapping with superficial temporal artery-middle cerebral artery anastomosis.[20,21,26,27] The conventional wrapping, clipping and clipping on the wrapped aneurysm is problematic because of the aneurysm recurrence and rebleeding after the procedure.[21,23] Trapping must be able to completely prevent the rebleeding.[10] Low-flow bypass, such as the superficial temporal artery-middle cerebral artery anastomosis, seems to be sufficient for preventing ischemia distal to the aneurysm, as shown in current Case 9.[28]

Although a successful case of conservative treatment has been reported for subarachnoid hemorrhage caused by the dissection of the anterior cerebral artery, accurate diagnosis and prompt treatment are important because of the high re-bleed rate.[10,11,29] The operation is performed with wrapping, clipping, clipping on the wrapped aneurysm, simple surgical trapping, trapping with A3-A3 anastomosis, endovascular obliteration of the aneurysm, and endovascular stent.[13,22,27,29] Conventional wrapping or clipping is problematic because of the aneurysm recurrence and rebleeding after the procedure.[21,23] Simple surgical or endovascular trapping should be avoided, because cerebral infarction can occur.[29] However, revascularization with A3-A3 anastomosis is relatively difficult. Therefore, clipping on the wrapped aneurysm might be the best treatment choice, as shown in current Cases 10 and 11.

In the dissecting aneurysm of internal carotid artery aneurysm, posterior communicating artery, anterior choroidal artery or perforating artery of the internal carotid artery are frequently included in the dissecting portion. When these arteries can not be preserved by trapping, brain infarction is inevitable. In the case of middle cerebral artery aneurysm, the lenticulo-striate artery originating from the dissected portion also might be obliterated. Using endovascular stent-based methods in the future may help achieve stabilization of the dissected artery without sacrificing the arterial trunk and branches, but trapping should be performed in the present to prevent fatal rebleeding.[22,25]

There are various methods of treatment for ruptured dissecting aneurysms, but they have not been standardized yet. In the current series of dissecting aneurysms, our experience points toward the following treatment methods: In carotid artery aneurysm, trapping after high-flow bypass is recommended. The trapping after low-flow bypass is risky, because adequate cerebral blood flow is not secured. In middle cerebral artery aneurysms, trapping after low-flow bypass can be performed safely. In anterior cerebral artery aneurysms in which bypass surgery is relatively difficult, clipping on the wrapped aneurysm is also possible without causing re-bleeding. Although the cerebral infarction caused by the obstruction of arterial branch or perforating artery cannot be avoided in trapping operation, we consider that this kind of operation is mandatory to prevent fatal re-bleeding.

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