



Endovascular Trapping for Ruptured Blood Blister-Like Aneurysm of the Internal Carotid Artery: A Case Report and Review of the Literature

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Objective: Rupture of blood blister-like aneurysm (BBA) of the internal carotid artery (ICA) may result in fatal subarachnoid hemorrhage (SAH). Open surgery including bypass surgery has been performed to treat the aneurysm. Recently, endovascular treatment is developing for the treatment of cerebral aneurysm. Here, we report a case of ruptured BBA of the ICA, treated by endovascular trapping and review the literatures.

Case Presentation: A 37-year-old woman was brought to our hospital to treat SAH. Computed tomography (CT) angiography showed no apparent cause of the hemorrhage except for the minor dilation of the C2 portion of the left ICA. After 3 days, the CT angiography demonstrated progression of the dilation with the formation of a bleb. Evaluating collateral circulation through anterior communicating artery, endovascular trapping of the ICA was performed. Although she suffered minor ischemic stroke postoperatively, the symptoms recovered completely and discharged without neurological deficit.

Review of Literatures: we reviewed the 11 cases of ruptured BBA treated by endovascular trapping. The results of ICA occlusion based on the evaluation of collateral circulation were satisfactory because rebleeding as well as regrowth of the aneurysm were prevented. However, hemodynamic compromise and treatment for vasospasm following SAH are considered.

Conclusion: Rebleeding from BBA of the ICA should be prevented first and ischemic complication is avoided secondary. Endovascular trapping following evaluation of the collateral circulation is definitive treatment of BBA of the ICA.

Keywords ► internal carotid artery aneurysm, anterior wall blister-like aneurysm, subarachnoid hemorrhage, endovascular parent artery occlusion

Introduction

Blood blister-like aneurysm (BBA) of the internal carotid artery (ICA) is a subtype of arterial dissection and quite fragile.¹⁾ Japanese retrospective study on BBA of the ICA showed that the ratio of preoperative rebleeding was as high as 16.9% (52/307) and early stage treatment was recommended.²⁾ As an open surgery, wrapping of the aneurysm or trapping with bypass has been performed.³⁾

However, intraoperative rebleeding occurs frequently and surgical technique is difficult.^{4,5)} Recently, endovascular treatment including stent-assisted coil embolization is developing to treat for BBA.^{6,7)} We perform endovascular trapping for BBA of the ICA based on evaluation of collateral flow. Here, we report a case of BBA treated with endovascular trapping and review literatures.

Case Presentation

A 37-year-old woman suffered from sudden onset headache and vomiting visited nearby hospital and subarachnoid hemorrhage (SAH) was detected. She was brought to our hospital and neurological examination showed mild consciousness disturbance without motor weakness. Computed tomography (CT) showed diffuse SAH (**Fig. 1A**). Her consciousness level was E3V4M6 of Glasgow coma scale and she was diagnosed as a Hunt and Kosnik grade III SAH. CT angiography showed no apparent cause of the hemorrhage except for the minor dilation of the C2 portion

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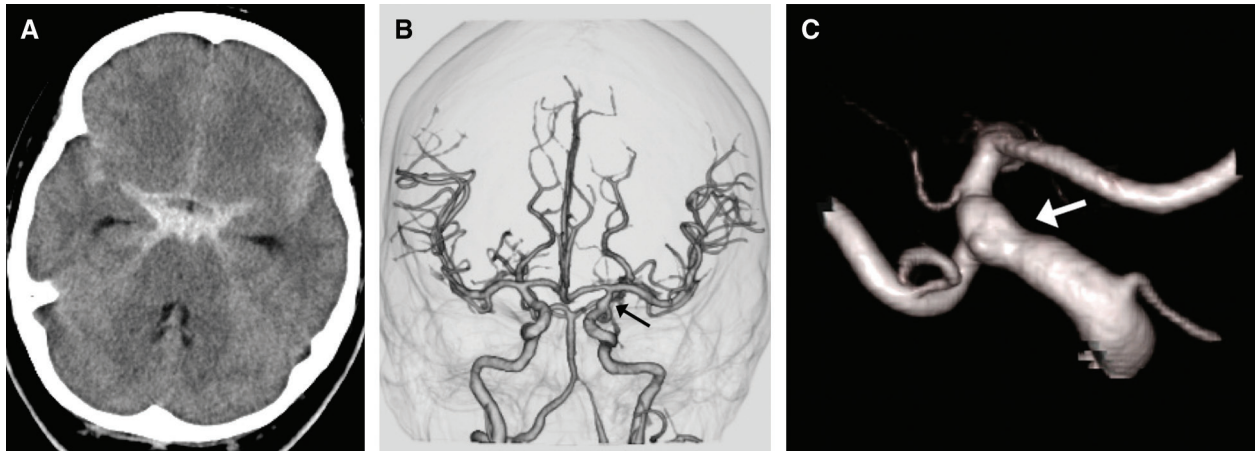


Fig. 1 CT on admission. (A) CT shows diffuse subarachnoid hemorrhage. (B) CT angiography shows minor dilatation of the left C2 portion of the left ICA (arrow). (C) Left carotid angiography (3D

image) shows mild dilation of the C2 portion of the ICA. CT: computed tomography; ICA: internal carotid artery

of the left ICA (**Fig. 1B**). Subsequently, the lesion was evaluated with digital subtraction angiography and irregular dilation of the C2 portion was detected (**Fig. 1C**). The posterior communicating artery was involved to the dilation but anterior choroidal artery was not. In the Matas test of manual compression at the cervical portion of the left ICA, the collateral flow from and anterior communicating artery was good. And collateral flow from posterior communicating artery was also shown in the Allcock test. We treated the patient conservatively, since the angiographic change of the left ICA is minor. After 3 days, the CT angiography demonstrated progression of the dilation as well as appearance of the bleb (**Fig. 2**). And we confirmed the lesion as BBA of the ICA and endovascular treatment was planned the day.

Endovascular treatment

Under general anesthesia, a 7 French sheath introducer was placed to the right femoral artery. After heparinization (activated clotting time: more than 200 seconds), 7 French Optimo balloon guiding catheter (Tokai Medical Products, Aichi, Japan) was navigated to the left ICA. Angiography demonstrated progression of the dilation and formation of a bleb (**Fig. 3A**). The mean arterial stump pressure of the balloon occlusion test decreased from 77 mmHg to 60 mmHg and regional saturation of the oxygen (rSO₂) did not decrease from 65%. We considered the cerebral circulation as tolerance for the ICA occlusion. Since open surgery during subacute phase of SAH might induce cerebral vasospasm, endovascular trapping was performed using double catheter technique. The relation of the BBA and anterior choroidal artery and posterior communicating

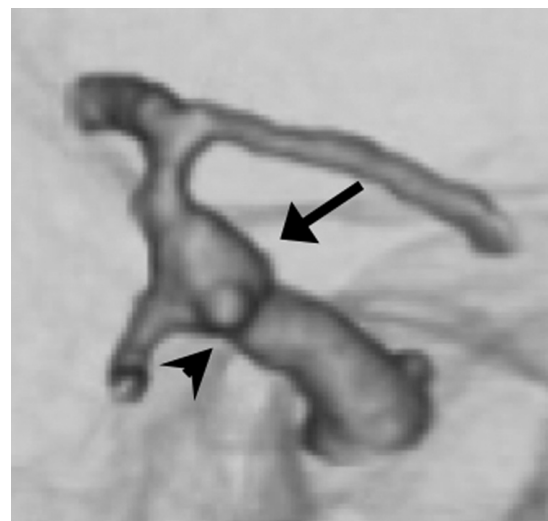


Fig. 2 CT angiography 3 days later shows progression of the dilation of the C2 portion of the ICA (arrow) and appearance of the bleb (arrowhead). ICA: internal carotid artery

artery was identified (**Fig. 3B**), and SL10 microcatheter (Stryker, Kalamazoo, MI, USA) was navigated to the posterior communicating artery using GT wire (Terumo, Tokyo, Japan) and Excelsior1018 microcatheter to the mid portion of the BBA and the Target XL 5 mm × 15 cm (Stryker) was placed to the BBA preserving the origin of the anterior choroidal artery (**Fig. 3C**). Under proximal flow control using balloon guiding catheter, Target XL coil 3 mm × 9 cm, Target XL coil 3 mm × 9 cm, Target XL coil 3 mm × 9 cm, Target XL coil 2 mm × 6 cm and Target XL coil 2 mm × 6 cm are placed to the flaring from Excelsior microcatheter. Angiography showed occlusion of the ICA preserving the ophthalmic artery (**Fig. 3D**). Finally,

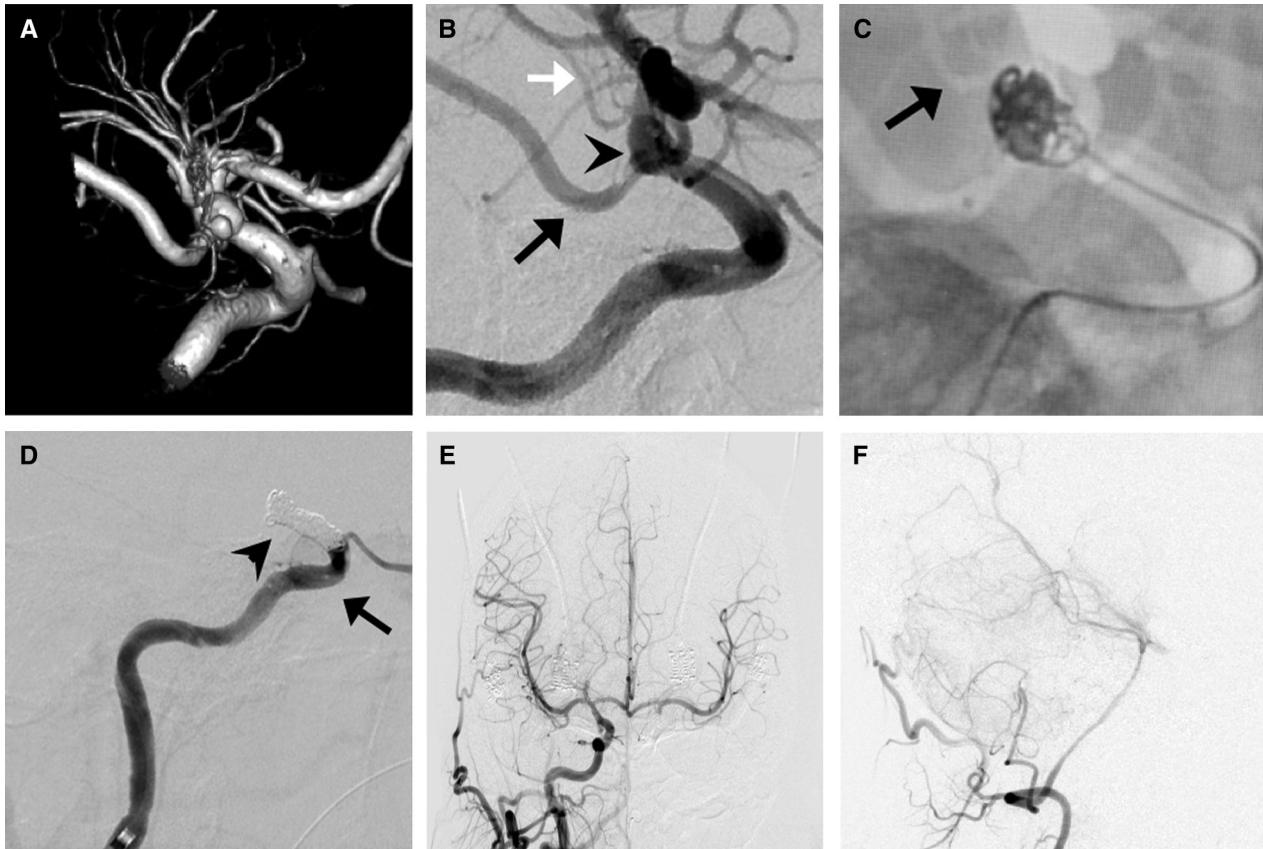


Fig. 3 Left carotid angiography and endovascular treatment. (A) Left carotid angiography 3D image shows significant dilatation of the C2 portion of the ICA with formation of the bleb. (B) Left carotid angiography with working angle shows relationship aneurysm (arrowhead), anterior choroidal artery (white arrow), and posterior communicating artery (black arrow). (C) Intraoperative fluoroscopy shows placement of first coil, preserving the anterior choroidal artery

(arrow). (D) Post-procedural carotid angiography (lateral view) shows occlusion of the ICA (arrow) and the aneurysm (arrowhead). (E) Right carotid angiography showed collateral flow to the left middle cerebral artery. (F) Left vertebral angiography (lateral view) showed antegrade flow of the left posterior cerebral artery. The flow via the left posterior communicating artery was not observed. ICA: internal carotid artery

retrieving SL10 microcatheter, Target ultrasoft 2 mm × 4 cm was placed into the coil mass for the tighter packing. Right carotid angiography showed collateral flow to the left middle cerebral artery (**Fig. 3E**) and left vertebral angiography showed antegrade flow of the left posterior cerebral artery (**Fig. 3F**). The flow via the left posterior communicating artery was not observed.

Postoperative course

Postoperatively, her consciousness was alert but she had mild right hemiparesis. Brain MR diffusion-weighted image revealed acute ischemic lesion at left thalamus as well as left watershed ischemia (**Fig. 4A**). MR angiography showed occlusion of the left ICA with BBA and patency of the left middle cerebral artery and left posterior cerebral artery (**Fig. 4B**). The vasospasm was treated with prophylactic administration of ozagrel sodium 80 mg/day and fasudil hydrochloride hydrate 90 mg/day for 14 days

followed by cilostazol 200mg/day permanently. The hemiparesis improved gradually and she discharged without neurological deficit 30 days later. Three months later, mild hypoperfusion (10% decrease comparing contralateral circulation) of the left middle cerebral artery area was detected with quantitative ^{123}I -IMP single-photon emission tomography, but bypass surgery did not indicated. One year later, her condition is excellent and MR images showed neither additional ischemic lesion nor recurrence of BBA (**Fig. 5**).

Discussion

Surgical treatment including wrapping or trapping with bypass has been performed to treat BBA of the ICA.^{3,5} During surgical treatment, we are able to examine the lesion directly as rupture of the BBA even in the minor morphological change. The disadvantage of the surgical treatment is its invasiveness and intraoperative rebleeding

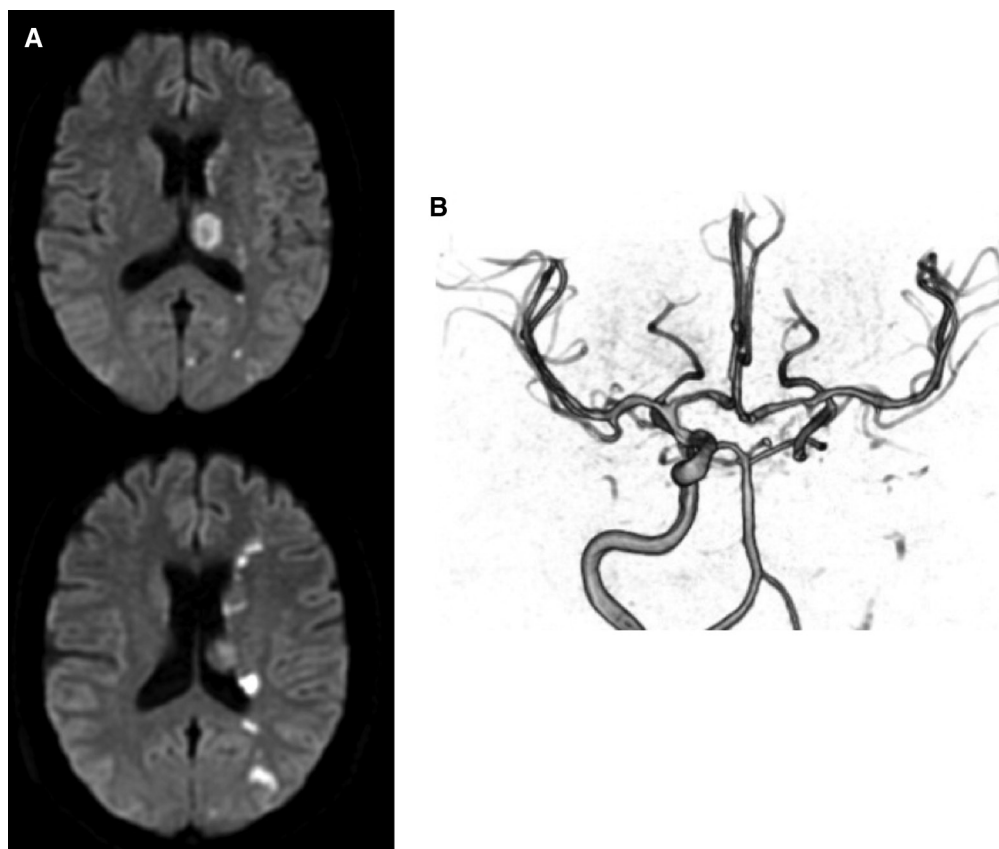


Fig. 4 Postoperative MRI (A) Diffusion-weighted image shows left thalamic infarction as well as shower embolism in the left cerebral hemisphere. (B) MR angiography shows occlusion of the left ICA. The left middle cerebral artery and left posterior cerebral artery are visualized well. MRI: magnetic resonance imaging

because of the fragility of the lesion. Thus, SAH results in cerebral swelling, which lead to more difficult situation for direct surgery as well as bypass surgery.

Endovascular treatment is developing markedly along with production of new devices. For the BBA of the ICA, simple coiling is not possible because of the morphological features.¹⁾ If the collateral circulation is enough, endovascular trapping including the lesion segment can be employed for the BBA. We evaluated the collateral circulation with stump pressure and monitoring rSO₂ in addition to Matas test and Allcock test.⁸⁾ We consider the hemodynamic tolerance if the mean arterial stump pressure is kept more than 30mmHg and rSO₂ change is less than 10% during balloon occlusion. In our previous study on ICA giant aneurysms, ICA was able to occluded without bypass more than half of the cases.⁸⁾ Park et al. recommended ICA trapping as a first option.⁹⁾ Technically, the pathological ICA should be occluded in short segment and they employ two microcatheters (one for framing and one for compact packing). Thus, blocking the proximal ICA flow by balloon allows secure and stable coil placement.⁹⁾ We modified more sophisticated strategy with balloon

guiding catheter and occluded the lesion preserving anterior choroidal artery as well as ophthalmic artery. In our case, posterior communicating artery was involved with BBA and ICA was occluded including origin of the posterior communicating artery. Postoperatively, she suffered from mild right hemiparesis due to the left thalamic infarction, which may be due to the occlusion of the perforating artery from posterior communicating artery, namely anterior thalamoperforating artery.¹⁰⁾ Moreover, scattered watershed infarctions were accompanied in the left cerebral hemisphere (**Fig. 4A**). We consider the cause of the infarction as intraoperative thrombo-embolism with hemodynamic compromise of left cerebral hemisphere.¹¹⁾ To prevent that, we need to keep intraoperative blood pressure higher.

We reviewed the 11 cases of ruptured BBA of the ICA treated by endovascular trapping (**Table 1**).^{9,12-16)} In seven cases, endovascular trapping was employed as initial treatment and it was employed as rescue treatment in four cases. If the endovascular trapping was performed following evaluation of the collateral flow, the prognosis was satisfactory. In one case, vasospasm following SAH resulted

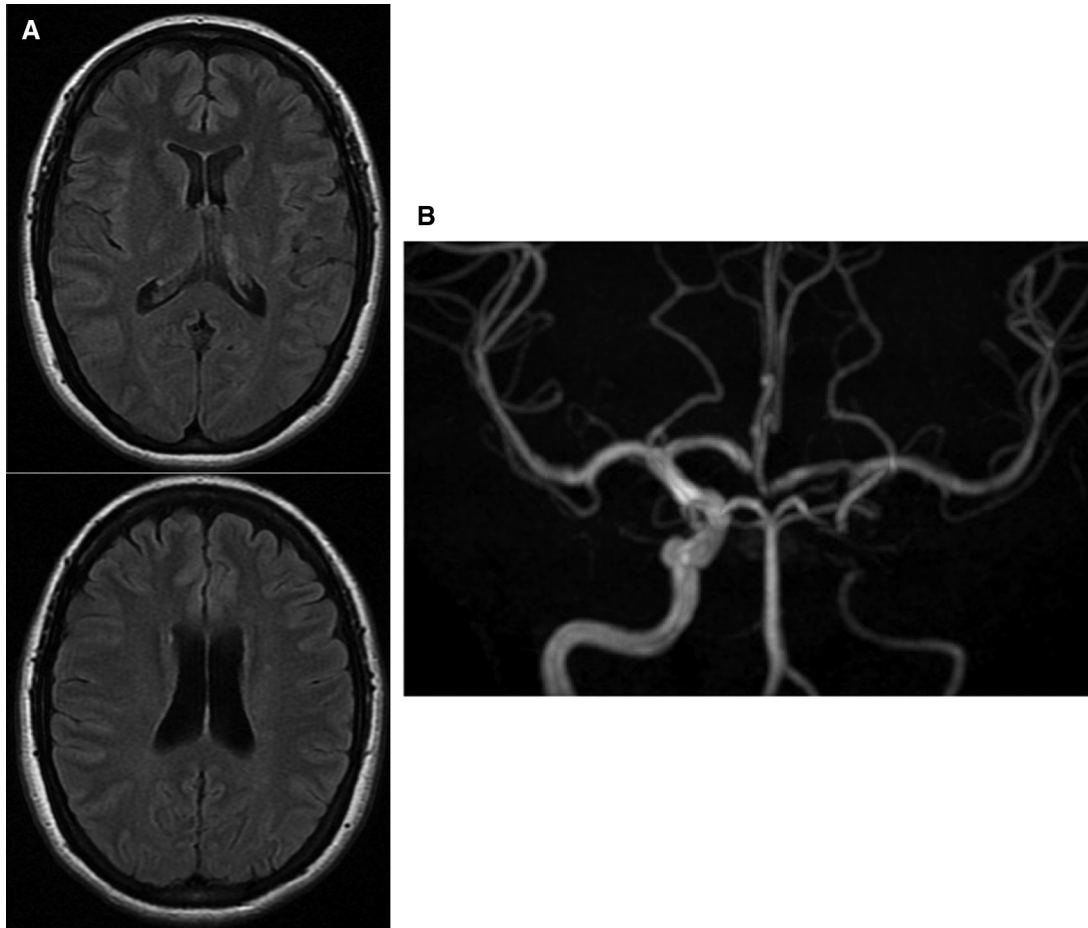


Fig. 5 Follow-up MRI 1 year later. **(A)** FLAIR image shows no newer ischemic lesion. **(B)** MR angiography shows occlusion of the left ICA and disappearance of aneurysm. ICA: internal carotid artery; MRI: magnetic resonance imaging

in fatal cerebral infarction.¹⁵⁾ Hemodynamic compromise is another problem of the endovascular trapping since endovascular treatment for the vasospasm is limited. Intra-arterial administration of the vascular dilator navigating microcatheter from contra-lateral side is reported.⁹⁾ Fortunately, prophylactic administration of ozagrel sodium was effective in our case. Thus, hypertensive and hypervolemic therapy may be indicated. Recently, stent-assisted coil embolization is employed as reconstructive treatment for BBA of the ICA.¹⁷⁾ However, acute thrombosis for the stent may occur and loading of antithrombotic agents and dual antithrombotic agents are required to prevent the complication.¹⁴⁾ Moreover, administration of antithrombotic agents may induce rebleeding. Postoperatively, regrowth of the aneurysm is frequently seen and additional treatment is needed. In terms of medical insurance term, stent is contraindication to treat ruptured aneurysm in Japan. Covered stent may more effective to prevent rebleeding, but has disadvantage on preservation of the branch arteries.¹⁸⁾ Flow

diverter is another alternative device to treat BBA of the ICA and preliminary results have been reported.¹⁹⁾

Limitation of the balloon occlusion test includes the difference the level of occlusion in the treatment and test occlusion, which cervical portion of the ICA. The test occlusion at the BBA is too dangerous to try. And collateral flow from ophthalmic artery or posterior communicating artery affect the cerebral circulation under test occlusion of the cervical portion of the ICA. In case of intolerant for the ICA occlusion, we would perform bypass surgery and try surgical trapping or endovascular trapping.

Conclusion

Re-rupture of BBA of the ICA should be prevented avoiding ischemic complication. Endovascular trapping following evaluation of the collateral circulation is definitive treatment of ruptured BBA of the ICA.

Table 1 Summary of ruptured blister-like aneurysm of the internal carotid artery treated by endovascular trapping

Reference	Age	Sex	H&K	Initial treatment	Complication	Rescue treatment	Prognosis	Rebleeding	Aneurysm
9	45	F	II	Wrapping, coiling	Regrowth	Trapping	GR	None	Occluded
9	32	F	II	Trapping	None	None	GR	None	Occluded
9	24	M	II	Trapping	None	None	GR	None	Occluded
9	38	F	II	Trapping	Intraoperative bleeding	None	GR	None	Occluded
12	52	M	V	Trapping	Major infarction	Hemicraniectomy	mRS 6	None	NA
13	36	F	NA	Trapping	Embolism	Surgical trapping	mRS 2	None	Occluded
14	44	F	II	Trapping	None	None	mRS 2	None	Occluded
14	44	M	III	Double stent	Thrombus	Trapping	mRS 0	None	Occluded
14	50	M	IV	Stent&coil	Thrombus	Trapping	mRS 0	None	Occluded
15	52	F	III	Coiling	Not achieved	Trapping	mRS 6	None	NA
16	48	M	II	Trapping	None	None	mRS 1	None	Occluded
Present	37	F	III	Trapping	Minor infarction	None	mRS 1	None	Occluded

GR: good recovery of Glasgow outcome scale; H&K: Hunt and Kosnik grade; mRS: modified Rankin Scale; NA: not applicable

Disclosure Statement

All authors declare no conflict of interest.

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