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Exclusion of the anterior communicating artery with endovascular flow diverters – A possible treatment method of a wide-necked aneurysm

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ABSTRACT

Introduction: We describe a case of a patient with severe subarachnoid hemorrhage from the rupture of difficult-to-treat morphology, a suspected partially thrombosed anterior communicating artery aneurysm.
Case presentation: The patient was admitted with World Federation of Neurosurgeons (WFNS) score of 4 and a Fisher grade IV hemorrhage. Angiography demonstrated a wide neck anterior communicating artery aneurysm not suitable for the standard coiling and surgical treatment. On the 10th day after the bleeding, endovascular treatment was performed to exclude the anterior communicating artery from the circulation by implanting flow diverters to A2 to A1 on both sides. On Day 18, a CT[1] scan showed communicating hydrocephalus, and thus the patient was treated with a ventriculoperitoneal shunt. At the four-month follow-up, angiography showed O'Kelly-Marotta grade D aneurysm occlusion, and the patient's modified Rankin score was 0. The patient made a complete recovery.
Discussion: Even though this was a rare application of the flow diverter, other treatment approaches, including detachable coil, stent implantation, and surgical clipping were considered less safe and less effective treatment in this case of anterior communicating artery aneurysm.
Conclusion: Endovascular exclusion of the anterior communicating artery from the circulation may be a safe and effective treatment approach in cases without significant perforant artery branches where the conventional endovascular treatment is not considered to be applicable.

1. Introduction

The conventional therapeutic approach to acutely treat a ruptured anterior communicating artery (ACOM) aneurysm is coil embolization. However, aneurysms defined as wide–necked or partially thrombosed sometimes pose significant technical challenges for conventional techniques. [1].

2. Case presentation

A adult patient presented with SAH[2] (WFNS 4). A non-contrast CT scan showed Fisher grade IV bleeding, and CT angiography identified a suspected partially thrombosed ACOM aneurysm as the source of the bleeding (Fig. 1). A ventricular drain was urgently implanted to manage secondary hydrocephalus. DSA[3] confirmed a multilobulated, irregular, wide-neck ACOM aneurysm, supplied from both A1 segments of the anterior cerebral artery (ACA). The neck of the aneurysm incorporated the whole length of the ACOM (Fig. 1), and subcallosal, hypothalamic perforating branches and the branch to the optic chiasm were not present.

We identified a number of signs that lead us to suspect that the bleeding originated from a partially thrombosed giant aneurysm:

– the lesion caused slight midline shift;
– the lesion was large and nearly circular, while its inside was filled

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[1] Computed tomography.
[2] Subarachnoid hemorrhage.
[3] Digital subtraction angiography.

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both with hyperdense, suggesting thrombosis, and hypodense material;

– the lesion was surrounded by a notable amount of vasogenic edema, which is uncommon in the context of the relatively small size of the aneurysm in the DSA image and would also support the hypothesis of intrasaccular thrombus formation.

Due to the above considerations, the aneurysm was found to be not suitable for simple or balloon–assisted coil embolization due to the expected high risk of recanalization caused by the large intrasaccular thrombus present in the aneurysm. Therefore, delayed flow diverter technique or surgical treatment were considered as possible approaches. Due to the aneurysm being partially thrombosed and ruptured, surgery was considered high-risk. The flow diverters of the correct size were not available at the time of the DSA and patient was in severe condition with suspected poor prognosis, therefore, the decision was made to perform delayed endovascular treatment with flow diversion. Until the intervention, the patient was monitored at the intensive care unit. An external ventricular drain (EVD[4]) was urgently implanted in order to manage the hydrocephalus secondary to the intraventricular bleeding and allow intracranial pressure monitoring. Transcranial Doppler ultrasonography (TCD[5]) detected mild vasospasm and the patient was also diagnosed with pneumonia. In spite of these complications, the patient remained stable with improving pulmonary status and mild cerebral vasospasm. Ten days later, WFNS score was reevaluated, and it showed a marked improvement from a score of 4 at admittance to a score of 2. Therefore, we decided to treat the aneurysm. The patient was administered 180 mg ticagrelor via the nasogastric tube, and 500 mg acetylsalicylic acid was administered intravenously prior to the intervention. The procedure was performed via the right femoral artery. A 5F intermediate catheter was advanced into the supraclinoid ICA[6] through a 6F long sheath. A 021 microcatheter was inserted into the ACA on the left side. The microcatheter temporarily occluded the ACA due to a severe vasospasm, which was relieved by intraarterial infusion of nimodipine. A SILK Vista baby 2,5 × 15 mm flow diverter was implanted in the left ACA from the A2 to the A1 segment. After the placement of the flow diverter, the aneurysm ceased to fill from the left side (Fig. 2).

Then, a 021 microcatether was advanced to the right ACA–A2 segment. This was followed by opening another SILK Vista baby 2,5 × 15 mm from the right A2 to the A1. This flow diverter did not fully open in the middle part, which limited the flow in the right ACA. Therefore, the device was opened with a Transform balloon (3 × 5 mm). Subsequently, the flow was restored, while the aneurysm was completely occluded (Fig. 3).

Dual antiplatelet therapy (DAPT) was continued for the following six months, with lifelong acetylsalicylic acid therapy.

Delayed hydrocephalus was confirmed nine days after the aneurysm treatment, and a ventriculoperitoneal shunt operation was performed. Before the procedure, a one-day dose ticaglerol was missed. The patient received 8 units of platelet suspension during the operation. The procedure was completed with no complications. At four months after the treatment, the modified Rankin Scale score was 0. Follow-up angiography revealed patent flow diverters, O'Kelly-Marotta grade D aneurysm, and occlusion of the ACOM (Fig. 4).

We also intended to validate the presumed partially thrombosed state of the aneurysm using magnetic resonance imaging (MRI[7]), but the patient declined due to claustrophobia.

3. Discussion

Excluding a part of the circle of Willis is a rare application of the flow diverter. A case of blister aneurysm has been reported to be successfully treated by excluding the ACOM [1]. In our case, the ACOM was excluded from the circulation using an endovascular technique for the treatment of a ruptured partially thrombosed aneurysm with a difficult-to-treat

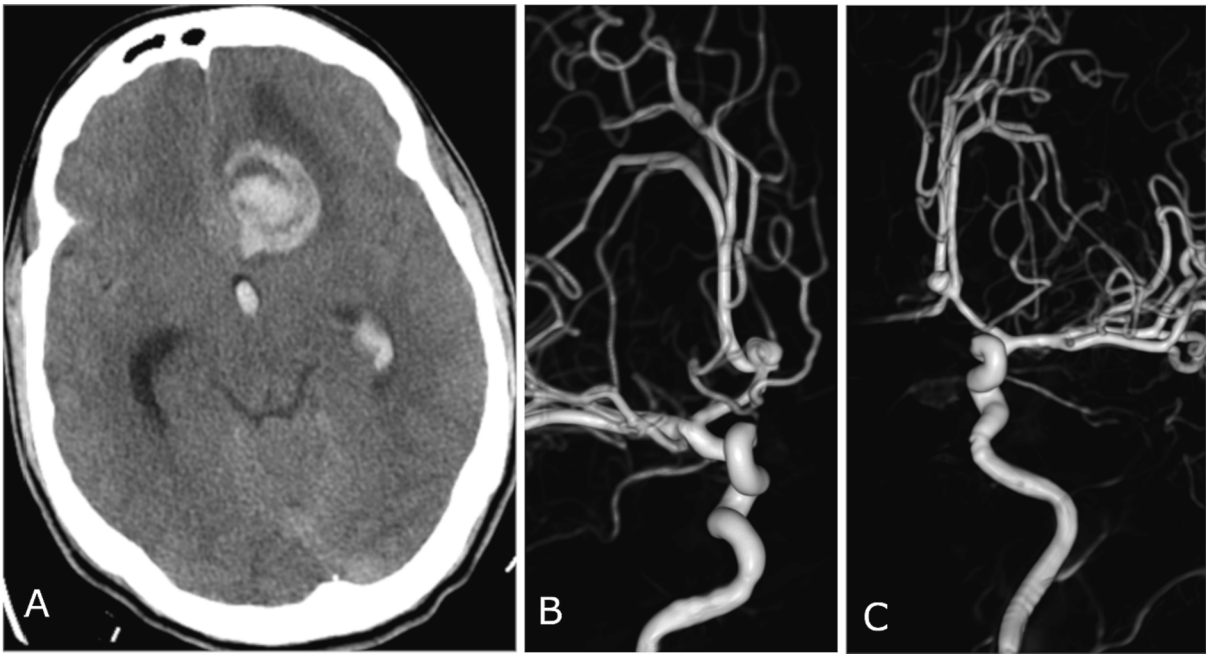

Fig. 1. (A) CT scan of the brain revealing blood in the subarachnoid and intraventricular spaces. (B) DSA angiography showing a multi-lobule, irregular anterior communication artery aneurysm, supplied from the right anterior cerebral artery (C) DSA angiography showing that the anterior communication artery system was also supplied form the left cerebral artery. The neck of the aneurysm incorporated the whole anterior communicating artery.

[4] External ventricular drainage.
[5] Transcranial Doppler ultrasonography.
[6] Internal carotid artery.
[7] magnetic resonance imaging.

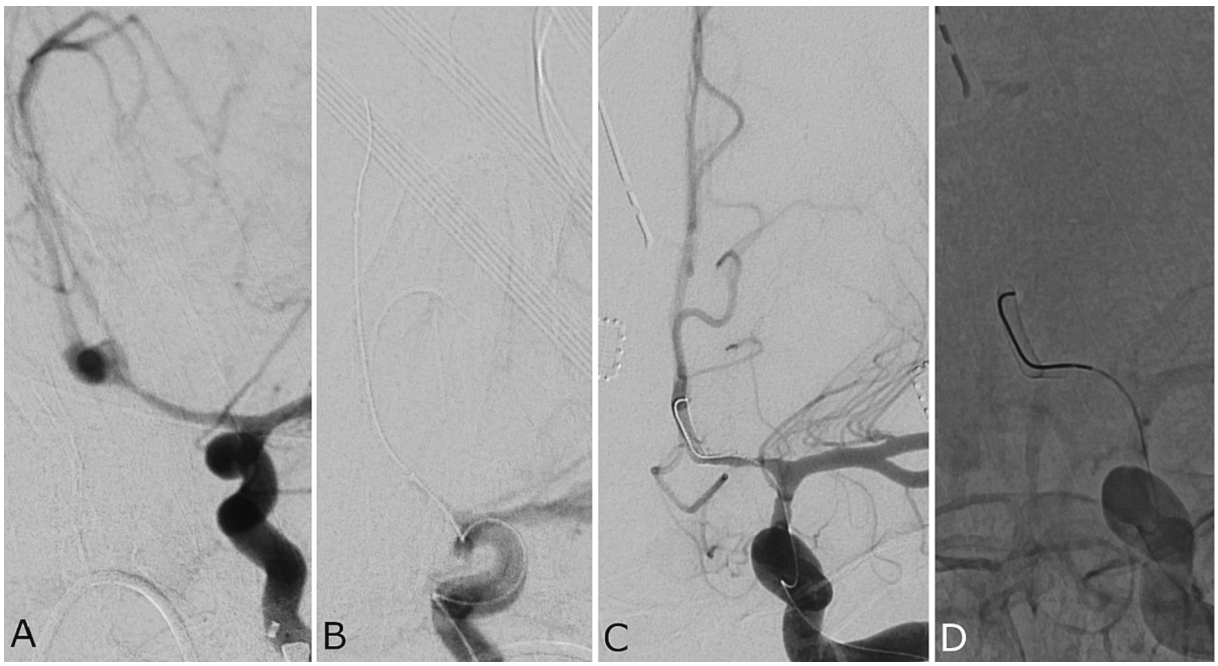

Fig. 2. (A) Intraprocedural angiography from the left internal carotid artery shows the multi-lobulated, irregular aneurysm and the vasospasm of both ACAs. (B) After the insertion of the microcatheter into the ACA, the ACA ceased to fill due to severe vasospasm. Intra-arterial nimodipine treatment was started immediately. (C) Several minutes later, the spasm decreased and the SILK Vista baby 2,5 × 15 mm flow diverter was inserted and opened. (D) The follow-up angiogram without subtractions shows the position of the flow diverter.

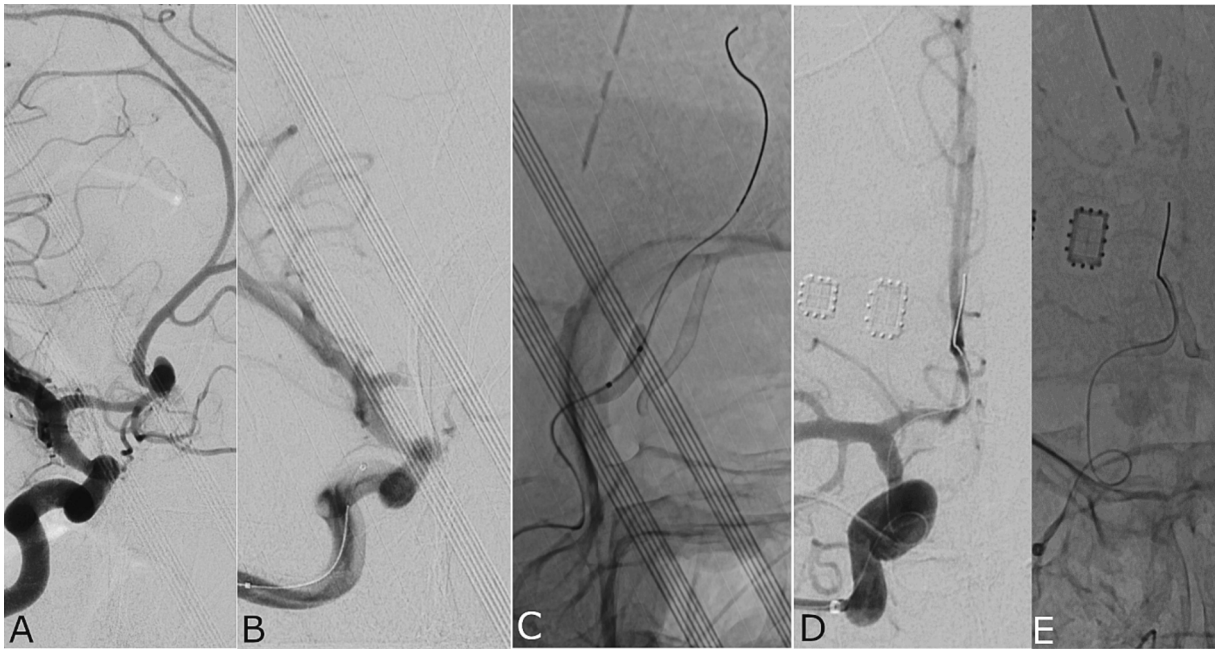

Fig. 3. (A) During treatment, angiography of the right internal carotid artery shows the aneurysm (B) SILK Vista baby 2,5 × 15 mm flow diverter was inserted and opened, and the ACA ceased to fill. (C) The flow diverter was fully opened with a 3 × 5 mm Transform Complient balloon. (D) The follow-up angiogram shows that the aneurysm is not filling. (E) The follow-up angiogram without subtractions show the position of the flow diverter.

morphology.

Among the available treatment possibilities, detachable coil alone was not considered a safe approach due to the morphology of the aneurysm, as it would have markedly increased the risk of anterior cerebral artery occlusion. Furthermore, the recanalization risk of the partially thrombosed aneurysm would have also been high. Even though intrasaccular flow disruption devices, such as WEB or Contour, are available and would have been a relevant option, the author performing the procedure had insufficient experience with such devices at the time of the treatment. Another possible solution would have been to implant laser–cut or braided stents on both sides from A2 to A1, preserving the flow of the anterior cerebral artery on both sides. However, coil application would have also been necessary, which might have led to the occlusion of the ACOM. Implanting X-configured cross-kissing stents on both sides with detachable coil, from A1 on one side to A2 on the other side would have also been possible [2,3]. This variation would have

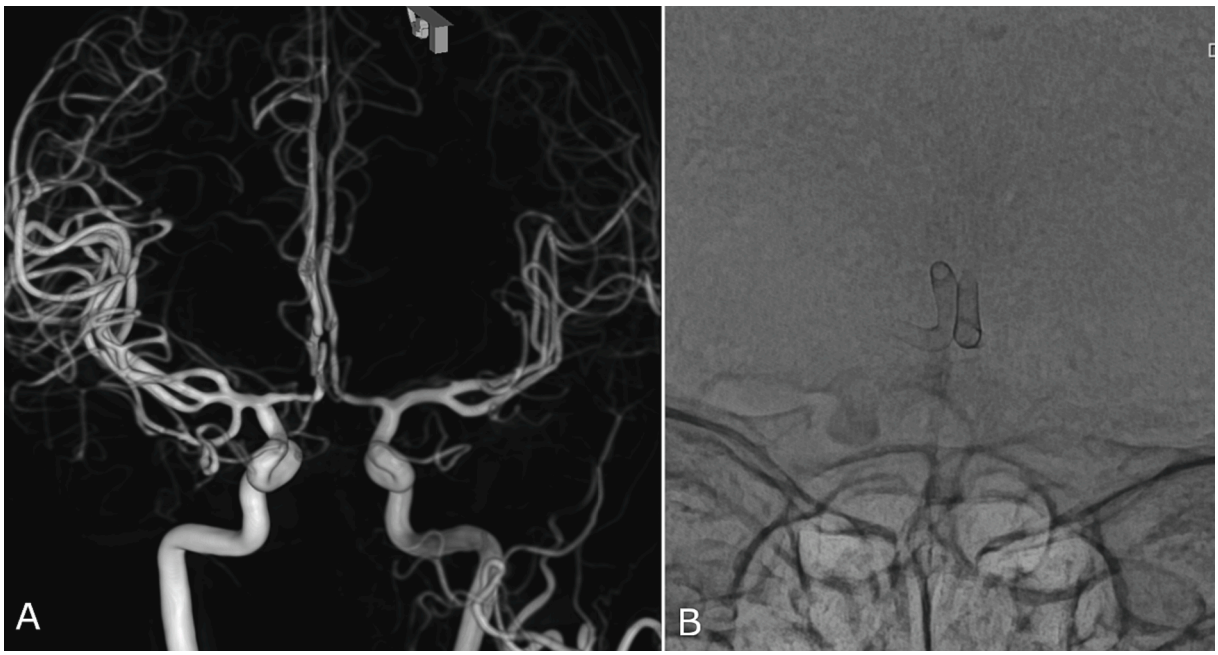

Fig. 4. (A) Follow-up MIP(Maximum intensity projection) 3D reconstruction that shows the excluded aneurysm and the occluded anterior communicating artery. (B) The position of the flow diverters in relation to both anterior cerebral arteries on an angiography image without substraction.

helped to preserve the ACOM. This method should be considered if preserving the ACOM is required, possibly due to a significant perforating branch. Another feasible treatment option would have been surgical clipping. In this case, exclusion of the ACOM by clips would have been possible, because the neck of the aneurysm included all parts of the ACOM. Perforating branch occlusion is the most notable risk during ACOM exclusion. However, this risk can be avoided with the flow diverter technique [4,5].

Antiplatelet therapy should be carefully evaluated when a ruptured aneurysm is treated with a flow diverter or with the implantation of an intracranial stent. While the prevention of thrombotic complications is crucial, antiplatelet therapy may also increase the risk of hemorrhagic complications, especially following EVD insertion. In this case, EVD was our first choice, because of the overall condition of the patient and because of the hydrocephalus that had already been developed [6].

4. Conclusion

Based on the reported case, we conclude that the endovascular exclusion of the ACOM from the circulation might be a treatment approach to consider:

- if the conventional endovascular treatment is not considered to be applicable or safe; and
- if there are no significant perforant artery branches.

Declaration

The research did not receive any specific grant from funding agencies in the public, commercial, or non-for-profit sectors.

Ethical approval: This article contains studies with human participants performed by any of the authors. The registration number of the ethical approval is 173/2021.

Informed consent was obtained for experimentation with human subjects.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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