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Case Reports & Case Series (CRP)

# Marked morphologic change of cerebral vessel with coexistence of severe flow compromise during endovascular treatment for ruptured aneurysm

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A B S T R A C T

In the vasospasm periods, the optimal timing of treatment for ruptured intracranial aneurysms remains controversial. In generally, it was recommended that treatment for a ruptured aneurysm be delayed until its disappearance, but this might be associated with aneurysmal re-rupture resulting in a poor outcome. Endovascular technique has been developed for many years, early treatment after aneurysmal subarachnoid hemorrhage (SAH) seems to be technically feasible even in the period of severe vasospasm. The present cases report our experiences of endovascular treatment for ruptured aneurysm in the presence of severe angiographic vasospasm and discuss the pertinent controversy.

## 1. Introduction

In the past, the timing for treatment of a ruptured aneurysm in the presence of severe vasospasm has been a controversial topic. Some authors have reported an increased frequency of delayed cerebral ischemia and poor outcome in patients in whom aneurysm treatment was performed during this period [9–11,16]. Therefore, it has been recommended that direct treatment for a ruptured aneurysm be delayed until vasospasm has disappeared or abated; however, this may be associated with aneurysmal re-rupture, and not allow for optimal subsequent medical treatment including induced hypertension. However, due to rapid advances in the development of surgical and endovascular techniques, recent several studies have demonstrated that early treatment for ruptured aneurysm is technically feasible, reduces the risk for re-rupture, and appears to be associated with improved clinical outcome, especially in patients with good clinical condition on admission [3–5,9,14,15]. In endovascular coiling for ruptured aneurysm during periods of severe spasm, unexpected situations may arise. We present two cases in which aneurysms in the presence of severe vasospasm were treated using endovascular coil embolization, and discuss varying points of view during the procedures.

## 2. Case reports

### 2.1. Case I

A 48-year-old woman experienced sudden onset of headache, irritability, and confusion. Her family could not recall the exact time when the symptoms initially presented. Initial brain computed tomography revealed subarachnoid hemorrhage (SAH), and cerebral angiography revealed not only an anterior communicating artery (A-com) aneurysm, but also severe vasospasm involving both the anterior cerebral artery (ACA) and middle cerebral artery (MCA) (Fig. 1-A). The right ACA was not visualized and the left ACA was severely narrowed. Endovascular coiling was performed immediately. When the microcatheter was advanced near the aneurysm through the left ACA, blood flow arrest occurred in the total ACA territory (Fig. 1-B). The microcatheter was withdrawn to the internal carotid artery (ICA) bifurcation area and another microcatheter was positioned proximal to the ACA for angioplasty. We quickly first selected aneurysm with microcatheter, made from 2 coils, and immediately withdrew the microcatheter proximal to the ACA. After making the coil frame, a calcium channel blocker was administered continuously through another microcatheter located in the proximal ACA (Fig. 1-C). After waiting a few minutes, reselection and additional coiling was performed several times (Fig. 1-D). In this fashion, the aneurysm was obliterated and blood flow was well maintained in the ACA territory without the occurrence of a thromboembolic event. At final angiogram, the vasospasm was markedly improved (Fig. 1-E). Five days after embolization, the patient presented right-side weakness, and a repeat angioplasty was performed. Although diffusion-weighted imaging revealed focal acute infarction in the frontal lobe, the patient was discharged with no neurological deficit, except for mild confusion. Three weeks after discharge, cognitive function and consciousness were clearly recovered.

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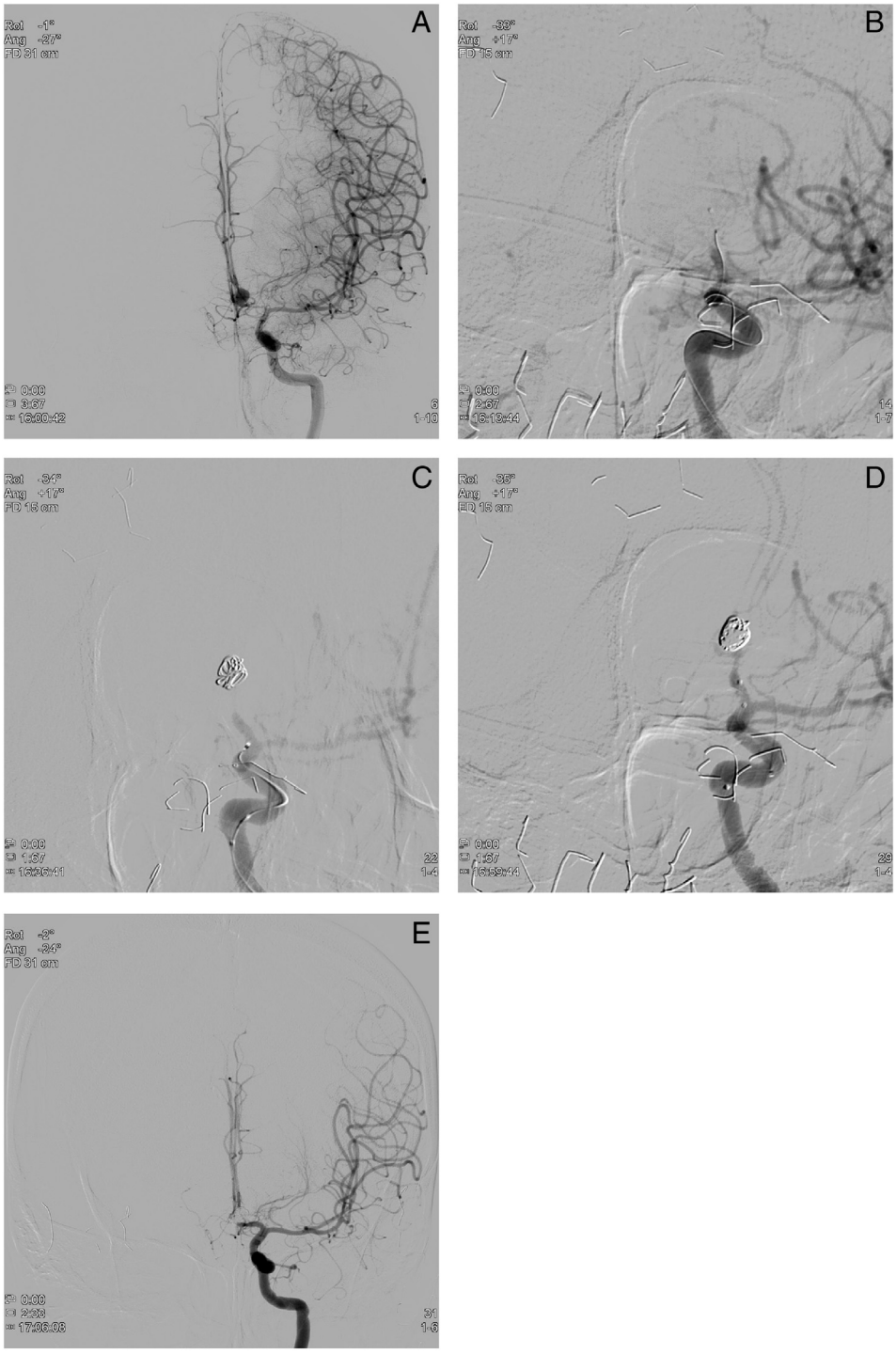


**Fig. 1.** A. Initial cerebral angiography reveals not only the anterior communicating artery (A-com) aneurysm but also severe vasospasm involving the anterior cerebral artery (ACA).
B. When the microcatheter is advanced near the aneurysm through the left ACA, blood flow arrest occurred in the total ACA territory.
C. After making the coil frame, a calcium channel blocker is administered continuously through another microcatheter localized to the proximal ACA.
D. After waiting for few minutes, reselection and additional coiling is performed.
E. At final angiogram, the vasospasm is markedly improved.

### *2.2. Case II*

A 57-year-old man experienced sudden onset of headache 10 days previously. On admission, the patient presented with transient dysphasia and weakness in both legs. Diffusion-weighted magnetic resonance imaging was reviewed in another department and revealed cerebral hemorrhage in the right inferior frontal gyrus and scanty SAH. Cerebral angiography revealed a ruptured distal ACA and unruptured MCA aneurysm. From the proximal portion of A2 to distal area, vasospasm was evident and especially severe in the proximal A2 to aneurysm neck (Fig. 2-A,B). Coiling was attempted immediately. When the microcatheter was advanced to the A2 segment through the left ACA, blood flow was not observed in the total ACA territory in angiogram (Fig. 2-C). An advance–withdrawal method (used in Case I) could

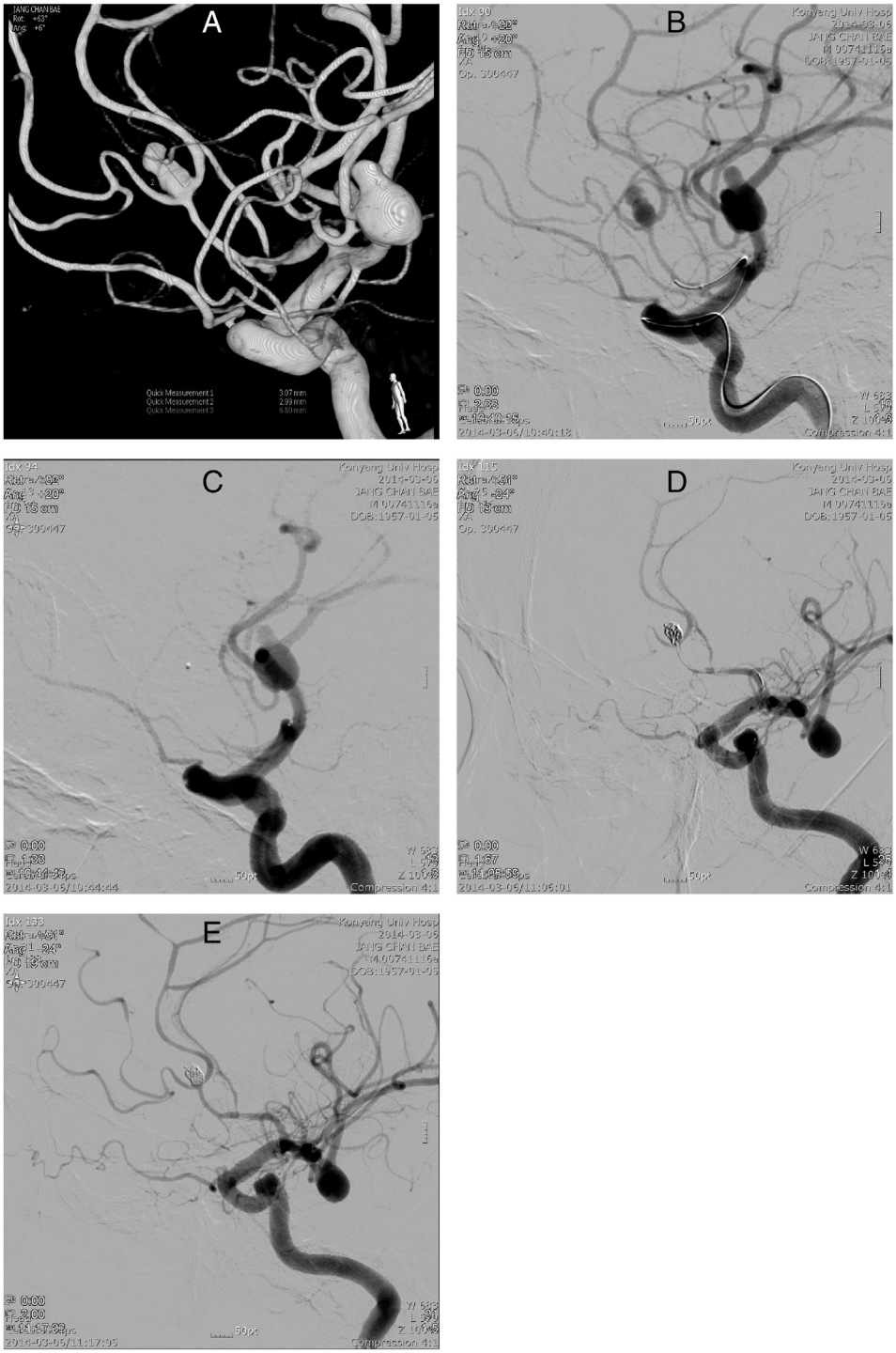


**Fig. 2.** A. Cerebral angiography reveals a ruptured distal anterior cerebral artery (ACA) and unruptured middle cerebral artery aneurysms.
B. Vasospasm is demonstrated, and is especially severe in the proximal A2 to the aneurysm neck.
C. When the microcatheter is advanced to the A2 segment through the left ACA, blood flow is not observed in the total ACA territory in angiogram.
D. A few minutes after withdrawal of the microcatheter to the bifurcation of the internal carotid artery (ICA), the angiogram revealed more dilated ACA and partial blood flow is observed.
E. At final angiogram, vasospasm is slightly improved without angioplasty.

not performed because the proximal portion of the A2 segment was curved, which introduced tension and jumping of the microcatheter. Several aneurysm selections with the microcatheter appeared to be dangerous and required more time in the selection of aneurysm. The microcatheter was withdrawn to the ICA bifurcation area and we waited several minutes. In the angiogram a few minutes later, the ACA was more dilated than before and, when microcatheter was advanced to the A2 segment, partial blood flow was observed in the ACA territory (Fig. 2-D). The aneurysm was obliterated, and blood flow was maintained with no thromboembolic event. At final angiogram, vasospasm was slightly improved without angioplasty (Fig. 2-E).

## 3. Discussion

Vasospasm appears most frequently from approximately 3 to 15 days after subarachnoid hemorrhage, and can severely impair cerebral blood flow and even cause cerebral infarcts [11]. During these periods of vasospasm, the optimal timing for treatment of ruptured intracranial aneurysms remains controversial. Some authors have suggested that direct surgery during the spasm period should be contraindicated, particularly in cases with higher Hunt & Hess grades [19] and, is therefore, recommended early [20] (before) or late [1,11] (after) the spasm period. There are some reports in which delayed cerebral ischemia, postoperative vasospasm, and poorer outcomes occur more frequently in patients who undergo aneurysmal treatment during the at-risk period for vasospasm, regardless of angiographic documentation [11,16,18]. Therefore, in the presence of severe vasospasm, it is generally recommended that treatment for a ruptured aneurysm be delayed until vasospasm disappears. However, this may be associated with aneurysmal re-rupture, resulting in a poor outcome. Nevertheless, the authors of a recent meta-analysis investigating the timing of aneurysm clipping surgery suggested that both early and intermediate surgical treatments improved outcomes in all clinical grades [4].

In direct surgery, dissection, manipulation, and/or temporary clipping of intracerebral arteries already irritated by subarachnoid blood may precipitate or exacerbate arterial narrowing [7,8,17]. Findlay [6] recommended that surgery during the vasospastic interval, 4 to 10 days following SAH, be undertaken with caution, owing to the possibility of aggravating latent cerebral ischemia, especially in the presence of significant cerebral vasospasm determined either by angiography or cerebral blood flow studies. In endovascular coiling in the spasm period, these risk factors that occur in direct surgery may be decreased during treatment. Given that endovascular treatment can reduce dissection, manipulation of the ruptured aneurysm and dilatation of the vasospastic arteries—either mechanically or pharmacologically—could be considered an alternative option for patients with symptomatic vasospasm on admission [13]. On the other hand, arterial irritation induced by catheterization or occlusion of a severely narrowed parent artery can be a concern. Evaluation of the effects of catheterization on spastic vessels after SAH has not been documented in detail. Wikholm et al. [21] reported endovascular surgery itself did not have an influence on the occurrence of vasospasm among patients treated within the first two days or in the spasm period itself (days 3 to 14). In a study by Kurata et al. [12] involving a small number of patients, the majority were treated without spasmolysis, which exerted a purely positive effect of catheterization on spastic vessels after SAH. The spastic vessels exhibited marked dilation after catheterization, and in only one case did infarction occur within the distribution area of the catheterized spastic vessels. Byrne et al. [2] reported that patients treated with endovascular coiling within six days of SAH experienced better outcomes than those treated later and, therefore, treatment should be performed as soon as possible after aneurysmal rupture.

When endovascular treatment is applied to a ruptured aneurysm with severe vasospasm, several points should be considered from the cases we presented. Although catheterization may not aggravate vasospasm, if the diameter of the vasospastic artery is too narrow, it can be occluded by the microcatheter itself and arrest cerebral blood flow to the distribution area. During or after aneurysmal selection with microcatheter, it is important to confirm maintenance of blood flow in the proximal and distal parts via cerebral angiogram. After temporary advance of the parent artery, the spastic artery can be dilated due to the pure effect of catheterization, and blood flow can be maintained in reselection. If the blood flow is insufficient or occluded in the affected artery after a few minutes, various techniques other than the conventional method (i.e., advance–withdrawal or contralateral approach) or combined treatment (i.e., intra-arterial angioplasty with vasodilating drugs or balloon) should be considered.

Although an aneurysm may appear to be obliterated completely or nearly completely under vasospasm conditions, we believe that recanalization will occur more frequently than when performed during the non-spasm period. Despite the appearance of complete packing in the vasospasm period, its permanence would not be maintained after increased blood flow in the affected vessel is restored after vasospasm disappears and, would therefore, require more frequent coil compaction. In cases involving severe vasospasm, early follow-up angiogram is required.

## 4. Conclusion

Our case presentations demonstrated that early endovascular treatment may be appropriate for ruptured aneurysm(s) during periods of severe vasospasm.

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