129 Basilar Artery Bifurcation Aneurysm: Spontaneous SAH and Recurrent Aneurysm Rupture During Computed Tomography Angiography

Georg Gihr, Franziska Dorn, and Hans Henkes

Abstract

A 70-year-old female patient experienced a spontaneous subarachnoid hemorrhage (SAH) due to the rupture of an irregular-shaped saccular aneurysm of the basilar artery (BA) bifurcation. Upon admission, her condition was equivalent to Hunt and Hess III with a Fisher grade of 4. During computed tomography angiography (CTA) with IV contrast medium infusion, her clinical condition deteriorated. CTA revealed a ruptured BA bifurcation aneurysm and massive contrast medium extravasation into the subarachnoid space due to the re-rupture of said aneurysm. A ventricular drain was inserted, and the aneurysm was occluded with coils as an emergency procedure. Severe posthemorrhagic vasospasm occurred during the further course, and the patient suffered multiple hemispheric infarctions and eventually passed away. Recently, more and more cases of early aneurysm re-rupture during CTA have been described in the literature. Whether this is a matter of a mere coincidence or related to the general circumstances or even CTA-induced is a matter of controversy. Whether CTA has to be regarded as a risk factor for early aneurysm re-rupture is not yet known. Early aneurysm re-rupture during CTA is the main topic of this chapter.

Keywords

Basilar artery bifurcation · Computed tomography angiography, CTA · Risk of re-rupture · Coil occlusion · Clipping · AcomA aneurysm · Vasospasm

Patient

A 70-year-old female patient with a medical history of arterial hypertension collapsed over breakfast and developed a subsequent disturbance in awareness. The initial Glasgow Coma Scale (GCS) score was 13. At presentation, an acute SAH caused by a ruptured basilar artery aneurysm was found.

Diagnostic Imaging

A non-contrast CT (NCCT) examination showed an extensive SAH with accentuation in the prepontine and interpeduncular cisterns as well as

G. Gihr (✉)
Neuroradiologische Klinik, Neurozentrum, Klinikum Stuttgart, Stuttgart, Germany
e-mail: g.gihr@klinikum-stuttgart.de

F. Dorn
Department of Neuroradiology, University Hospital of Munich, Campus Grosshadern, Munich, Germany
e-mail: franziskadorn@yahoo.de

H. Henkes
Neuroradiologische Klinik, Klinikum Stuttgart, Stuttgart, Germany
e-mail: hhhenkes@aol.com

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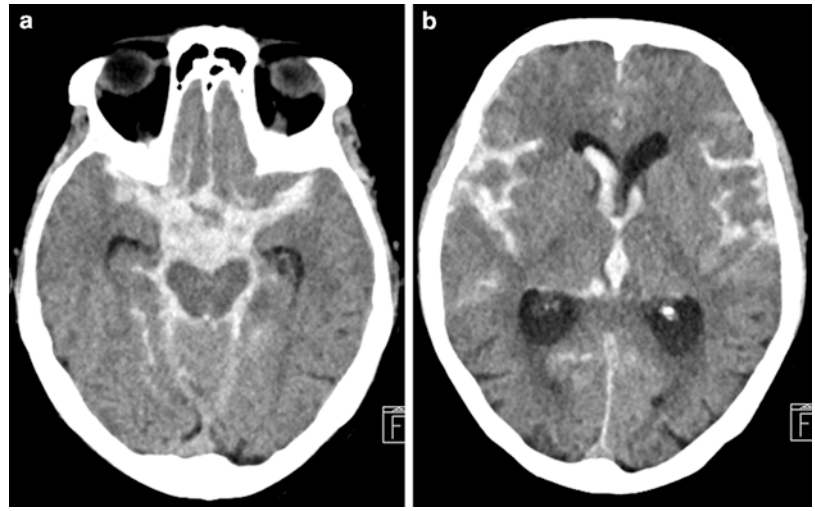

Fig. 1 Initial NCCT showing an extensive SAH, mainly in the interpeduncular cistern (**a**), as well as signs of an obstructive hydrocephalus due to intraventricular blood clots (**b**)

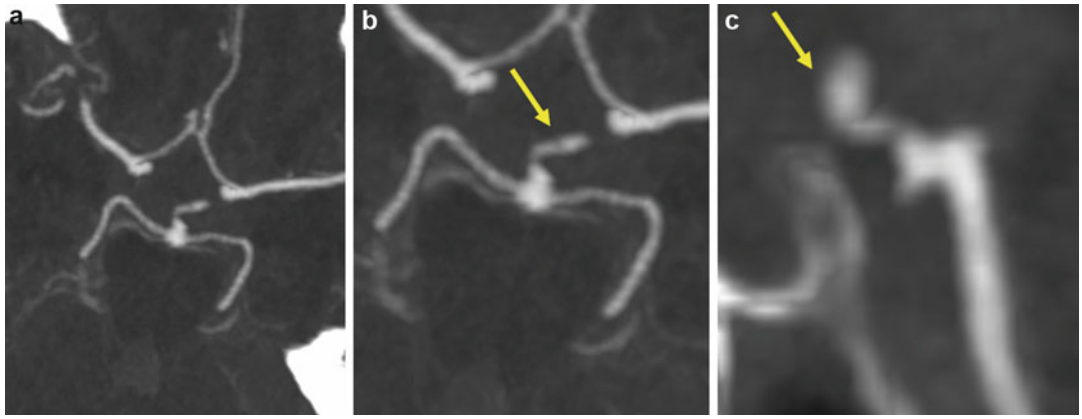

Fig. 2 Maximum intensity projection (10 mm slice thickness) of a CTA examination with transverse plane (**a, b**) and sagittal plane (**c**) reconstruction showing a basilar artery aneurysm with a contrast medium extravasation from a rupture site at the frontal-rostral aspect of the aneurysm (arrows)

intraventricular blood clots with ongoing signs of an obstructive hydrocephalus (Fig. 1).

The following CTA with the intravenous injection of 80 ml iomeprol (Imeron 350, Bracco Imaging) via peripheral venous access with a flow rate of 4 ml per second revealed an aneurysm on the basilar artery bifurcation, measuring 5 mm maximum fundus diameter with a 2 mm aneurysm neck. Moreover, CTA revealed a ribbon-like contrast medium extravasation from the aneurysm fundus indicating an active hemorrhage due to an aneurysm re-rupture (Fig. 2).

After inserting an external ventricular drainage (EVD) into the right lateral ventricle, the patient was referred to the angiography suite for further diagnostics and treatment. DSA confirmed the rostral basilar artery bifurcation aneurysm and revealed an additional small, wide-necked

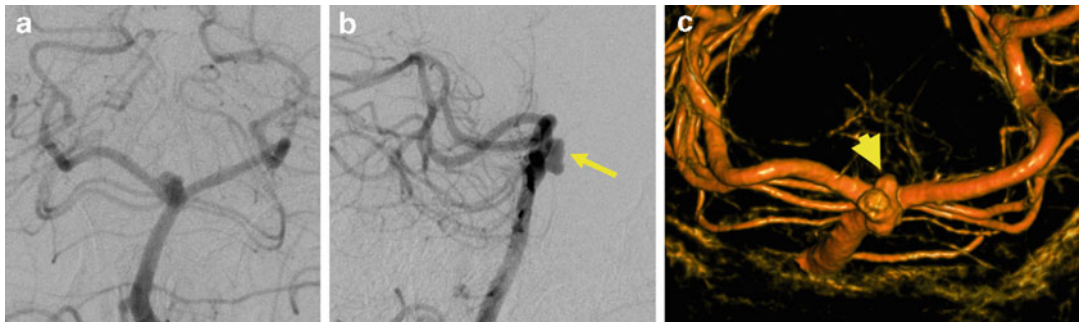

Fig. 3 DSA with injection of the left vertebral artery with posterior-anterior (**a**) and lateral (**b**) view and rotational angiography with 3D reconstruction (**c**), showing the anteriorly directed basilar artery bifurcation aneurysm (arrow) and an additional small aneurysm on the posterior aspect of the basilar bifurcation (arrowhead). The contrast medium extravasation had meanwhile ceased

aneurysm with a 2 mm maximum fundus diameter at the posterior aspect of the basilar artery bifurcation (Fig. 3).

Treatment Strategy

The goal of the treatment was to prevent another re-hemorrhage and to occlude the ruptured aneurysm as fast as reasonably possible. Since the location made the aneurysm less suitable for microsurgical clipping, the decision was made to proceed with endovascular coil occlusion.

Treatment

Procedure #1, 08. 01. 2016: coil occlusion of a re-ruptured basilar artery bifurcation aneurysm

Anesthesia: general anesthesia; 1× 5000 IU unfractionated heparin (Heparin-Natrium, Ratiopharm) IV

Premedication: 1 mg nimodipine (Nimotop S, Bayer Vital) via the guide catheter

Access: right common femoral artery, 1× 6F sheath (Terumo); *guide catheter*: 1× 6F Heartrail II (Terumo); *microcatheters*: 2× Excelsior SL-10 (Stryker); *microguidewire*: 1× Synchro2 0.014″ (Stryker)

Implants: coils, GDC 360° Soft 3/60 mm, Target 360° Nano 2/60 mm (both Stryker)

Course of treatment: the initial DSA run showed no further contrast medium extravasation. After 3D angiography and selecting a suitable working projection, the aneurysm was catheterized using a microcatheter. Under fluoroscopic control, two coils were placed into the aneurysm sac completely occluding it (Fig. 4).

Duration: 1st–14th DSA run: 96 min; fluoroscopy time: 23 min

Complications: none

Postmedication: prophylactic continuous infusion of 2 mg nimodipine (Nimotop S, Bayer Vital) IV per hour in the intensive care unit

Clinical Outcome

During the following days in the intensive care unit, the patient was still insufficiently aware despite the IV sedatives having been reduced. She also suffered several generalized epileptic seizures.

Follow-Up Examinations

The NCCT scan showed multiple demarcated infarctions in the anterior circulation of both hemispheres as a possible consequence of vasospasm (Fig. 5). To confirm the suspected

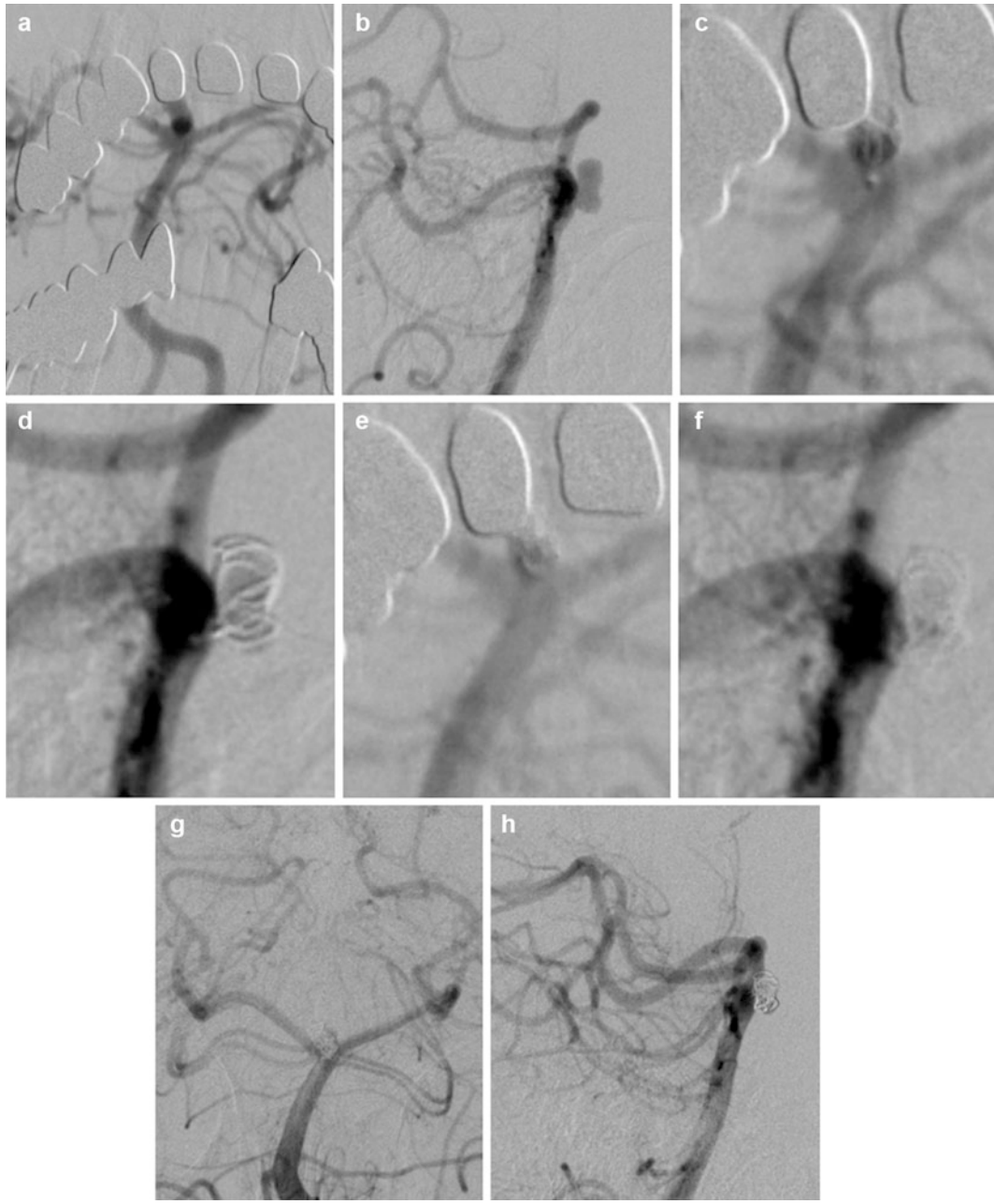

Fig. 4 DSA with injection of the left VA. Re-ruptured basilar artery bifurcation aneurysm prior (**a, b**), during (**c, d**), and after (**e, f, g, h**) coil occlusion of a basilar artery aneurysm with posterior-anterior (**a, c, e, g**) and lateral views (**b, d, f, h**), showing the complete occlusion of said aneurysm

diagnosis of diffuse posthemorrhagic vasospasm, the patient was again transferred to the angiography suite for further endovascular treatment, where subsequent DSA revealed pronounced vasospasm of the anterior and middle cerebral artery on both sides (Fig. 6).

Subsequent Treatment

Procedure #2, 16. 01. 2016: intra-arterial spasmolytic therapy through IA application of milrinone (Corotrop, Sanofi-Aventis)

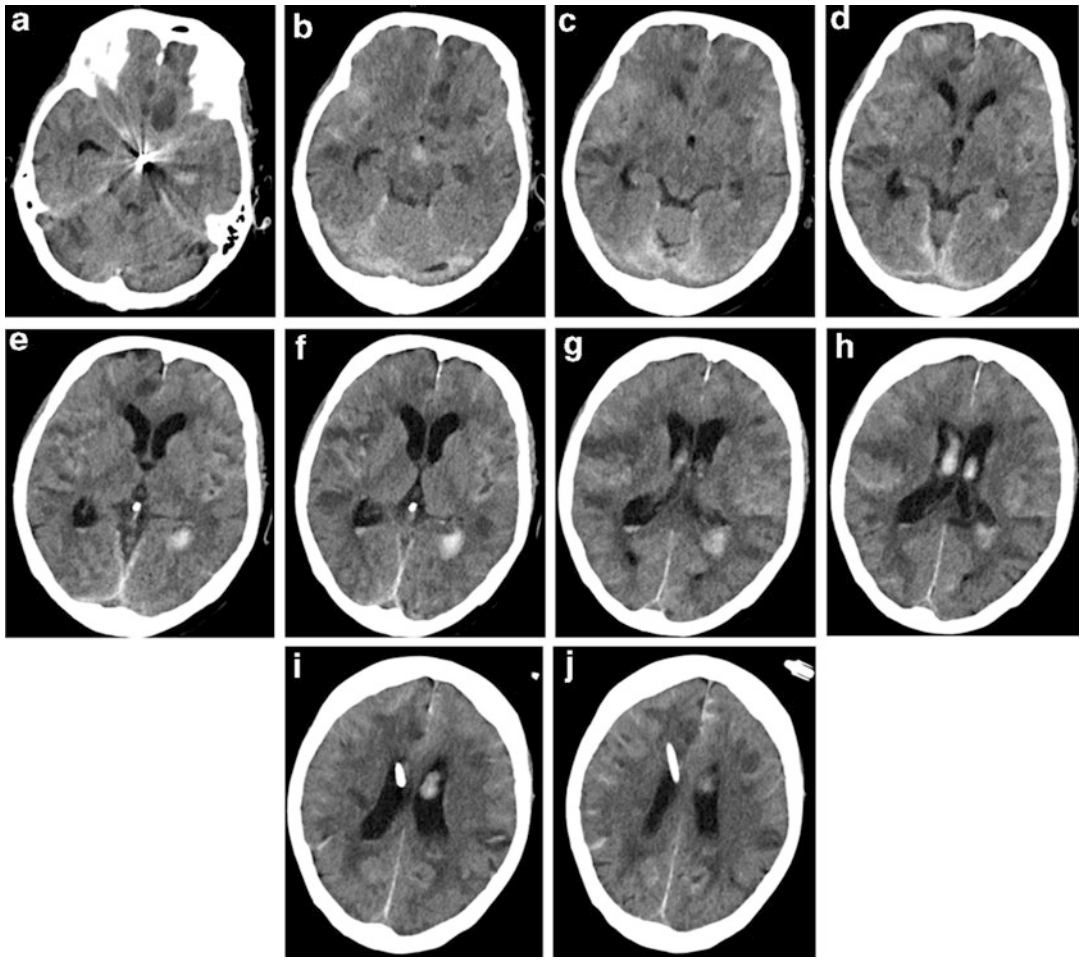

Fig. 5 NCCT examination with transverse planes ascending in a caudo-cranial direction (**a–j**) showing multiple demarcated infarctions of the anterior circulation of both hemispheres as a possible consequence of post-hemorrhagic vasospasm

Anesthesia: general anesthesia; 5000 IU unfractionated heparin IV

Premedication: none

Access: right common femoral artery, 1× 5F sheath (Terumo); *diagnostic catheter*, 1× 4F Tempo4 (Cordis)

Course of treatment: the initial DSA showed pronounced vasospasm of the anterior and middle cerebral artery on both sides. Therefore, it was decided to proceed with intra-arterial spasmolytic therapy. For this purpose, 8 mg milrinone was machine-injected over a 4F diagnostic catheter into each internal carotid artery during a 30-min period. The final DSA run showed only moderate resolution of the vasospasm (Fig. 6).

Duration: 1st–8th DSA run: 80 min; fluoroscopy time: 7 min

Complications: none

Postmedication: none

Clinical Outcome

In the further clinical course, the patient still presented persistent lack of awareness and insufficient spontaneous breathing. After consulting with her relatives and in the light of a poor functional prognosis due to the delayed ischemic parenchymal lesions, the decision was taken to

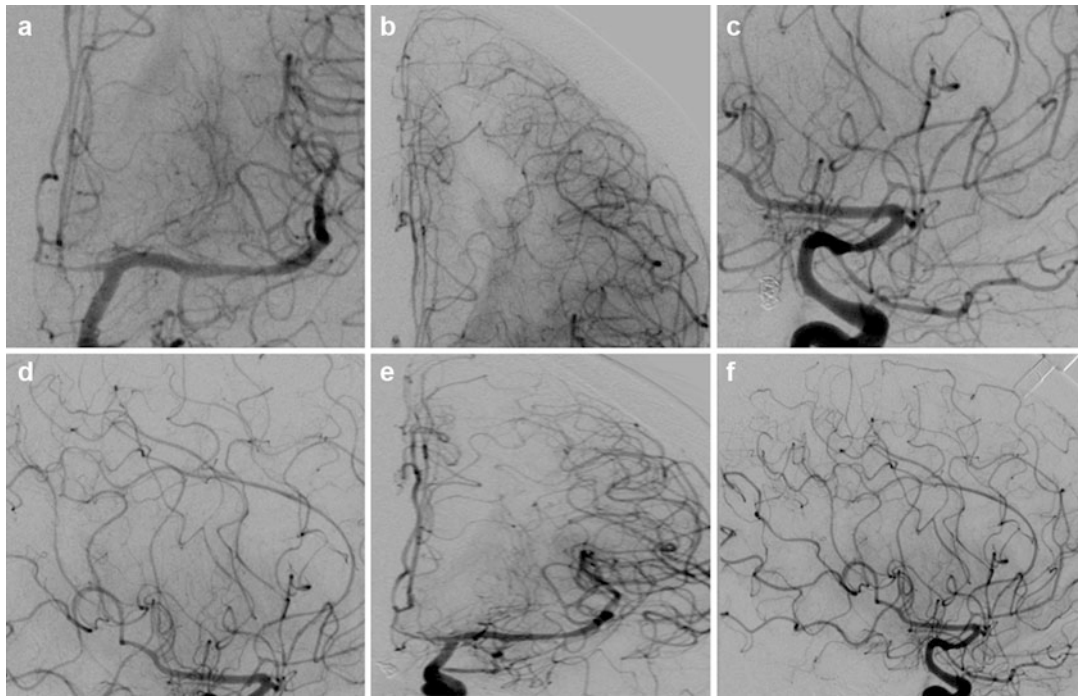

Fig. 6 DSA of the left ICA in posterior-anterior (**a, b**) and lateral (**c, d**) projection, revealing severe vasospasm of the middle and anterior cerebral artery in the proximal as well as in the peripheral artery segments. DSA after the infusion of 2 × 8 mg milrinone IA showing only moderate resolution of the vasospasm (**e, f**)

proceed with palliative care, and the patient died 4 days after being extubated on a general ward.

Discussion

As CT/CTA is a noninvasive and immediately available means of imaging, nowadays, it is widely used in first-line diagnostic work-up in hospital emergency settings. If an intracranial hemorrhage is suspected, the location, the extent of the hemorrhage, and the potential cause, including a ruptured aneurysm, can all be identified (Connolly et al. 2012; Steiner et al. 2013). Although it cannot offer the spatial resolution of catheter angiography, CTA is capable of detecting aneurysms with a high degree of sensitivity (Li et al. 2009; Papke et al. 2007). In the case of ruptured aneurysms as the cause of the initial SAH, re-rupture is a serious potential complication associated with significant mortality and morbidity (Broderick et al. 1994). Early aneurysm re-rupture most frequently occurs within the first 2–6 h. A number of risk factors associated with an increased risk of re-hemorrhage have been identified by several studies and are therefore widely accepted (Tang et al. 2014). These particularly include elevated systolic blood pressure, poor clinical condition graded at Hunt and Hess IV or V, the aneurysm being located in the posterior circulation, or having a large fundus diameter. The assumption of early catheter angiography being a causal factor for re-hemorrhage has also been advocated by several authors (Fujii et al. 1996; Inagawa 1994; Kusumi et al. 2005; Tanno et al. 2007), whereas the role of CTA in this context is still controversial. Some authors have commented that an aneurysm re-rupture occurring during CTA is a rare event, most likely coincidental, and at least less frequent than re-rupture during catheter angiography (Tanno et al. 2007). Nevertheless, an increasing number of cases with active extravasation during CTA have been reported (Desai et al. 2009; Gosselin and Vieco 1997; Hashiguchi et al.

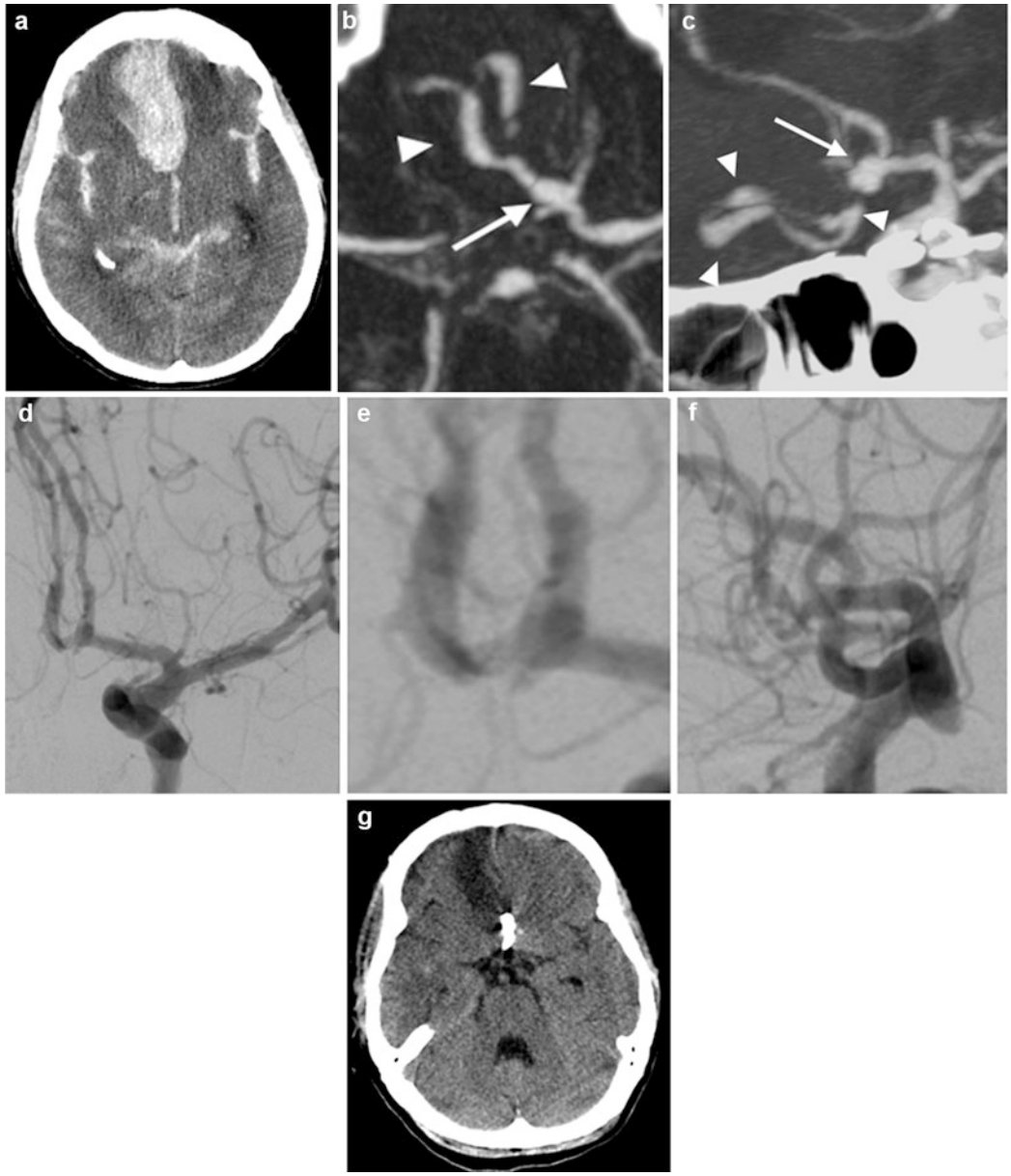

Fig. 7 A 52-year-old female patient with a spontaneous SAH, graded as Hunt and Hess III and Fisher 4. She was admitted to hospital after a sudden onset of headache, nausea, and her first generalized epileptic seizure. Clinical deterioration occurred immediately after arrival at the emergency room with a loss of consciousness during the CT/CTA examination, requiring subsequent intubation. The initial emergency NCCT showed an extensive SAH with an intracerebral hemorrhage (ICH) in the right frontal lobe (**a**). CTA revealed an aneurysm of the anterior communicating artery (AcomA, arrow) with extravasation of contrast medium (arrowhead) (**b, c**). The goals of the treatment were to prevent further hemorrhage, to occlude the ruptured aneurysm, and to evacuate the ICH from the right frontal lobe. To this end, and due to the location of the aneurysm, it was decided to proceed with surgery encompassing aneurysm clipping and hematoma evacuation. Follow-up DSA was performed 1 day after neurosurgical clipping and showed the complete occlusion of the aneurysm sac (**d, e, f**). An NCCT 2 weeks after surgery showed a hypodense defect in the right frontal lobe, the area where the hematoma had been evacuated. The patient recovered gradually with an mRS 3 after 90 days. To prevent posthemorrhagic communicating hydrocephalus, a ventriculoperitoneal shunt system was inserted

2007; Hassan et al. 2011; Holodny et al. 2003; Im et al. 2007; Josephson et al. 2004; Kobata et al. 2013; Nagai et al. 2008; Nakada et al. 2000; Nakatsuka et al. 2002; Perez-Nunez et al. 2006; Ryu et al. 2005; Scholtes et al. 2011; Tsuang et al. 2012; Yokota and Ida 2015), and retrospective single-center data analyses have revealed incident rates ranging from 3% (Hashiguchi et al. 2007) to 18% (Nakatsuka et al. 2002). Figure 7 shows another illustrative case of aneurysm re-rupture during CTA. There has even been a case described of the acute rupture of a previously asymptomatic intracranial aneurysm during a regular follow-up CTA (Dmytriw et al. 2016). Whether or not early CTA after initial aneurysm rupture increases the risk of re-hemorrhage is a subject of ongoing controversy. It has been viewed as being a matter of random coincidence due to the generally high incidence of re-rupture within the first few hours following the initial ictus (Nakatsuka et al. 2002), since unlike conventional angiography, CTA is not known to directly cause an elevation of the intracranial arterial blood pressure (Saitoh et al. 1996). However, all routinely used iodinated contrast media are known to have vasomotor effects per se (Limbruno and De Caterina 2003; Morcos et al. 1998) and may at least theoretically be able to induce changes in arterial blood pressure – even when given intravenously. CTA should therefore not be completely disregarded as a potential trigger of aneurysm re-rupture, and precautions, especially continuing stringent blood pressure monitoring and management, should be undertaken.

Therapeutic Alternatives

Conservative Management
Emergency Cliping
Emergency Coiling

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