



Basilar Artery Bifurcation Aneurysm: Recurrence and Significant Growth After Stent-Assisted Coil Occlusion, Hemodynamic Treatment Using pCANVAS and Medina Embolization Devices

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Franziska Dorn and Hans Henkes

Abstract

An initially asymptomatic wide-necked basilar bifurcation aneurysm was treated using the *waffle cone* technique for assisted coil occlusion. Four years later, the patient presented with gait disturbance, visual impairment, and cognitive decline. The MRI examination revealed an increase of the now largely thrombosed aneurysm with subsequent compression of the mid-brain and hydrocephalus. After implantation of a ventriculo-peritoneal shunt system, recoiling was performed and the patient improved moderately. However, follow-up MRI at 6 months revealed again a significant recurrence of the aneurysm. At this time, the hemodynamic treatment included the implantation of pCANVAS (phenox) in combination with Medina Embolization Devices (MED, Medtronic) with the expectation of achieving better coverage of the aneurysm neck while redirecting the flow away from the aneurysm entrance and providing dense packing of the aneurysm sac. Aneurysm recurrence

due to coil compaction, secondary aneurysm growth, and coil migration into an intrasaccular thrombus is a potential issue after coil occlusion alone and occurs in particular in large aneurysms. This case illustrates the challenge of treating broad-neck bifurcation aneurysms and highlights the potential advantage of an intra- and extrasaccular flow diversion and flow disruption concept for these patients.

Keywords

Basilar artery · Aneurysm recurrence · Bifurcation · Giant aneurysm · Broad-neck · pCANVAS · Medina · Waffle cone technique

Patient

Fifty-four-year-old female patient with a history of hypertensive basal ganglia hemorrhage in 2010 and an incidental saccular aneurysm of the basilar artery, without related neurologic symptoms at the initial presentation. After an uncomplicated treatment of the aneurysm in 2012, the patient was lost to follow-up and presented with severe clinical signs of midbrain compression 4 years later (gait disturbance, ataxia, visual impairment, dizziness, bradydiadochokinesis, and cognitive decline).

F. Dorn (✉)

Department of Neuroradiology, University Hospital of Munich, Campus Grosshadern, Munich, Germany
e-mail: franziskadorn@yahoo.de;
franziska.dorn@med.uni-muenchen.de

H. Henkes

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

Diagnostic Imaging

The initial angiogram revealed a wide-necked aneurysm of the basilar artery (Fig. 1a). At this time, magnetic resonance imaging (MRI) did not show any intrasaccular thrombus and no signs of midbrain compression (Fig. 1b).

Treatment Strategy

The aim of the first and second treatment was the prevention of a possible rupture and further growth of the basilar bifurcation aneurysm.

Treatment

Procedure #1, 14.02.2012: stent-assisted coil occlusion of a basilar bifurcation aneurysm, using *waffle cone* deployment of a Solitaire stent

Anesthesia: general anesthesia, 5000 IU heparin (Heparin-Natrium, ratiopharm) IV

Premedication: 1 × 100 mg ASA (Aspirin, Bayer Vital) PO daily, 1 × 75 mg clopidogrel (Plavix, Sanofi-Aventis) PO daily for 3 days

Access: right femoral artery, 6F sheath (Terumo); **guide catheter:** 6F Envoy (Codman Neurovascular); **microcatheter:** Rebar-18 (Medtronic), Excelsior SL-10 (Stryker); **microguidewire:** Synchro2 0.014" 200 cm (Stryker)

Implants: 1 × Solitaire 4/15 mm (Medtronic); 13 coils: Microplex 8/20, Microplex 7/30 (Microvention), Cashmere 5/12, Cashmere 4/8, Cashmere 4/6, Cashmere 3/6, Cashmere 3/6, Deltaplus 3/6, Deltaplus 3/6, Deltaplus 2.5/6, Cashmere 3/6, Deltaplus 3/6, Deltaplus 2.5/4 (all Micrus, now Cerenovus)

Course of treatment: initial treatment was performed using the *waffle cone* technique; for this, the right vertebral artery was catheterized with a 6F guide catheter. The aneurysm sac was catheterized with a microguidewire/microcatheter combination, and a self-expanding stent (Solitaire AB, Medtronic) was deployed in the basilar artery with the distal end entering the sac of the aneurysm (Fig. 2a). A second microcatheter was then

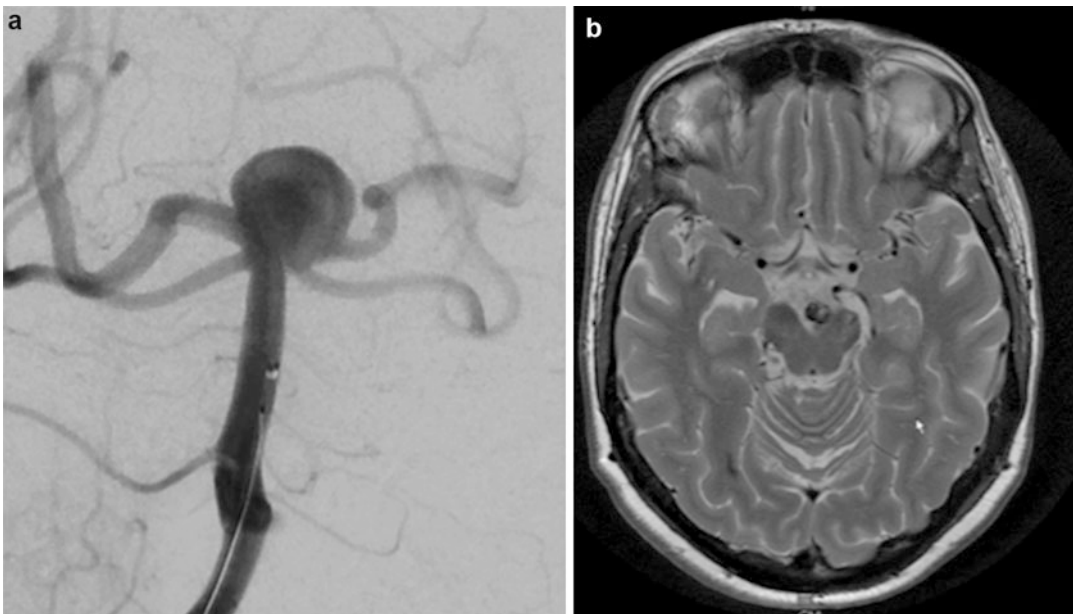


Fig. 1 Pretreatment angiography of a wide-necked basilar artery bifurcation aneurysm with a maximum diameter of 8 mm (a) posterior-anterior (PA) view). MRI did not show

intrasaccular thrombus formation or mass effect ((b) transverse T2WI)

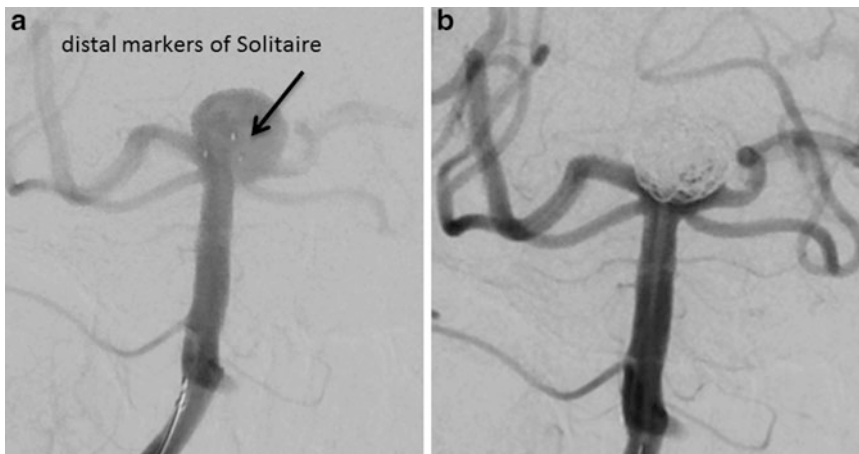


Fig. 2 Stent-assisted coil occlusion of a wide-necked basilar artery bifurcation aneurysm. The procedure included the deployment of a Solitaire self-expanding stent (Medtronic) in the basilar artery with the distal stent

markers at the aneurysm entrance, the so-called *waffle cone* technique (a) and subsequent coil occlusion. Final DSA run showed complete occlusion of the aneurysm (b)

placed in the aneurysm dome and the aneurysm sac was filled with 13 coils in total (Fig. 2b). Finally, the Solitaire stent was detached electrolytically.

Duration: 1st–12th DSA run: 209 min; fluoroscopy time: 65 min

Complications: none

Postmedication: 1 × 100 mg ASA PO daily lifelong, 1 × 75 mg clopidogrel (Plavix, Sanofi-Aventis) PO daily for 6 months

Clinical Outcome

The clinical condition of the patient remained unchanged without a neurological deficit.

Follow-Up and Subsequent Treatments

Follow-up MRI was performed not earlier than 4 years after the initial treatment, after a severe clinical deterioration had occurred. It revealed massive growth of the now largely thrombosed aneurysm (Fig. 3a, b) with subsequent signs of severe midbrain compression (Fig. 3c) and occlusive hydrocephalus (Fig. 3d). After implantation

of a ventriculo-peritoneal shunt system, recoiling of the aneurysm sac was considered.

Procedure #2, 04.08.2016: second coil occlusion of a basilar bifurcation aneurysm

Anesthesia: general anesthesia, 3000 IU heparin (Heparin-Natrium, ratiopharm) IV

Premedication: 1 × 100 mg ASA PO daily

Access: right femoral artery, 6F sheath (Terumo); *guide catheter:* 6F Envoy (Codman Neurovascular); *microcatheter:* Excelsior SL-10 (Stryker); *microguidewire:* Synchro2 0.014" 200 cm (Stryker)

Implants: 12 coils – Target XL 360° SOFT 7/20, Target XL 360° SOFT 6/20, Target 360° SOFT 4/6, Target Helical Ultra 3/6, Target Helical Ultra 3/6, Target 360° Ultra 3/8, Target 360° Ultra 2/3 (all Stryker), MicroPlex 10 HyperSoft Helical 2/6, MicroPlex 10 HyperSoft Helical 2/4, MicroPlex 10 Compass Complex 2/3, MicroPlex 10 Compass Complex 2/3, MicroPlex 10 Compass Complex 3/4 (all MicroVention)

Course of treatment: The left vertebral artery was catheterized with a 6F guiding catheter. Contrast injection confirmed central recanalization of the aneurysm. The aneurysm sac was catheterized with a microguidewire/microcatheter and subsequently filled with 12 coils in total, until complete occlusion was reached (Fig. 4).

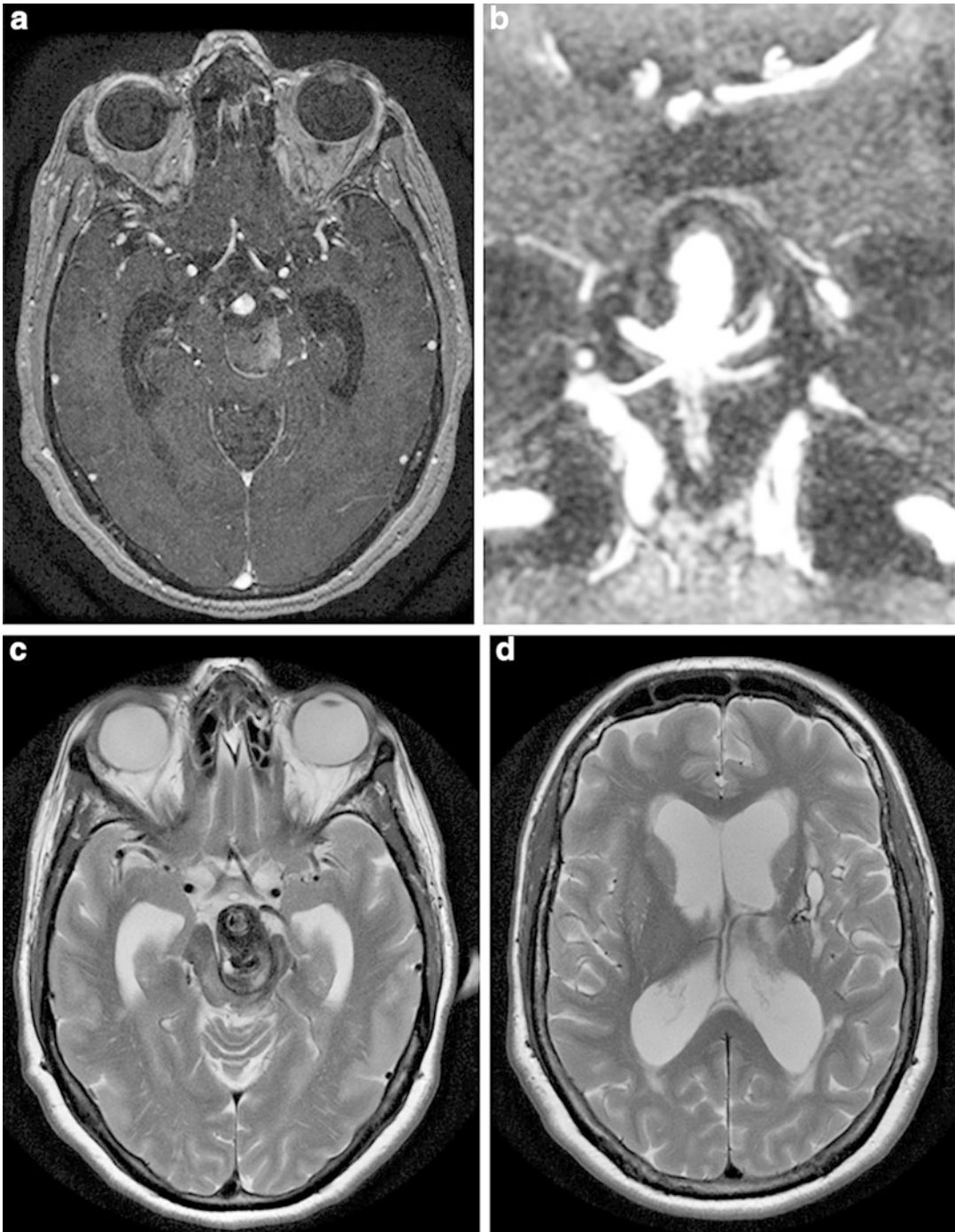


Fig. 3 MRI 4 years after the initial treatment showed massive aneurysm growth with a large thrombosed peripheral portion ((a) transverse and (b) coronal contrast-

enhanced MR-angiography) and subsequent signs of mid-brain compression and hydrocephalus ((c) and (d) transverse T2WI)

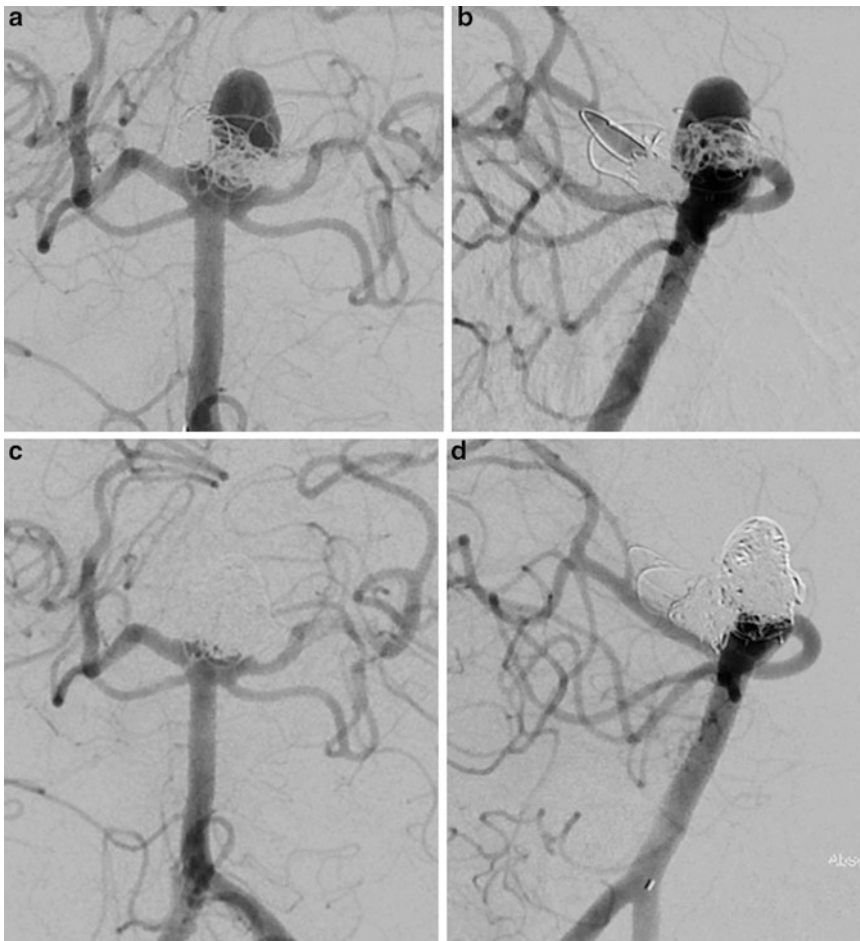


Fig. 4 DSA before the second treatment demonstrated central inflow and dislocation of the coils ((a) PA view, (b) lateral view). The final DSA run after the second coil

occlusion showed no residual inflow ((c) PA view, (d) lateral view)

Duration: 1st–25th DSA run: 70 min; fluoroscopy time: 45 min

Complications: none

Postmedication: 1 × 100 mg ASA PO daily lifelong

Clinical Outcome

The clinical condition of the patient improved moderately. However, a control MRI 6 months later demonstrated again the recanalization of the aneurysm (Fig. 5a–c).

Follow-Up and Subsequent Treatments

The aim of the third treatment was to achieve a definite elimination of the aneurysm from the circulation and to avoid further increase of aneurysm growth and any related midbrain compression. A combination of pCANVAS (phenox) and Medina Embolization Devices (MED, Medtronic) was chosen with the concept of combining flow diversion (pCANVAS) and intrasaccular flow-disruption (MED) while providing a maximum of packing density in the aneurysm sac.

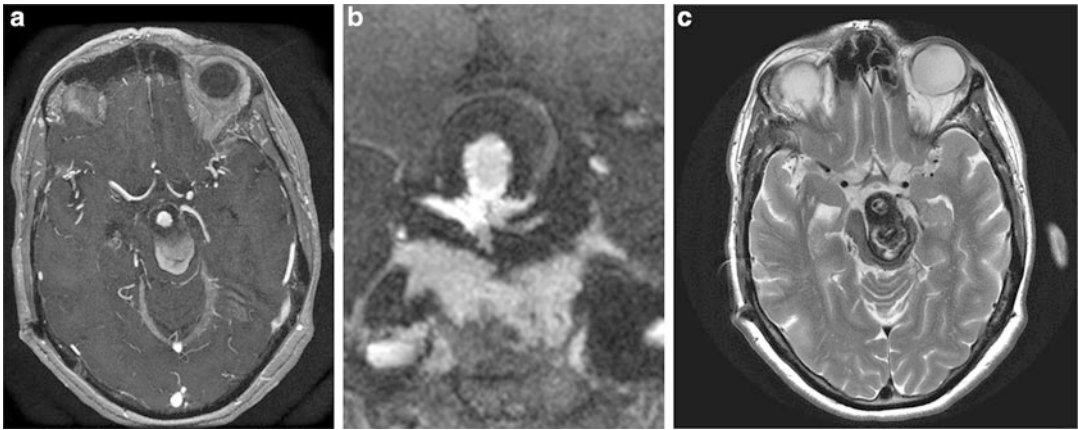


Fig. 5 MRI 6 months after the second treatment revealed recanalization of the aneurysm ((a) transverse, (b) coronal

contrast-enhanced MR-angiography) with unchanged signs of midbrain compression ((c) transverse T2WI)

Procedure #3, 21.07.2017: pCANVAS-assisted occlusion of the recurrent and growing basilar bifurcation aneurysm

Anesthesia: general anesthesia, 3000 IU heparin (Heparin-Natrium, ratiopharm) IV

Premedication: In addition to 1 × 100 mg ASA (Aspirin, Bayer Vital) PO daily, 1 × 75 mg clopidogrel (Plavix, Sanofi-Aventis) PO daily was started 7 days prior to the treatment and the effectiveness of both substances was proven by the Multiplate test (Roche Diagnostics) prior to the procedure.

Access: right femoral artery; 6F sheath (Terumo); left vertebral artery, 7F sheath (Terumo); **guide catheter:** 6F and 7F Envoy (Codman Neurovascular); **microcatheters:** RapidTransit 0.021" (Codman Neurovascular; for delivery of MED) and Excelsior XT-27 (Stryker; for delivery of pCANVAS); **micro-guidewires:** Synchro2 0.014" 200 cm (Stryker), Asahi Chikai black 18 (Asahi Intecc)

Implants: 1 × pCANVAS 4/20/6 (phenox); 11 × Medina Embolization Devices (MED); 2 × 6/8 framer, 3 × 6/6 filler, 2 × 7/7 filler, 4 × 5/5 filler (all Medtronic)

Course of treatment: The left VA was catheterized with a 6F guide catheter. DSA confirmed recurrent inflow into the neck of the aneurysm of the basilar artery bifurcation with a neck width of 6.3 mm and a longitudinal diameter of

9.3 mm (Fig. 6a, b). The aneurysm sac was catheterized with a 0.027" ID microcatheter (Fig. 6c), the petals of the pCANVAS were deployed and positioned at the level of the aneurysm neck (Fig. 6d, markers are covered by coils), the device was not yet detached. Thereafter, the right VA was catheterized with a 7F guide catheter and the membrane of the pCANVAS was penetrated for catheterization of the aneurysm sac with the second microcatheter. Finally, the aneurysm sac was occluded with 11 MEDs in total, until dense packing was achieved (Fig. 6e, f). After removal of the "coiling" microcatheter, the pCANVAS was detached electrolytically. The final angiogram confirmed a complete occlusion of the aneurysm and patency of both posterior cerebellar arteries (PCAs) (Fig. 6g, h).

Duration: 1st–20th DSA run: 138 min; fluoroscopy time: 64 min

Complications: none

Postmedication: 1 × 100 mg ASA PO daily lifelong, 1 × 75 mg clopidogrel PO daily for 6 months

Clinical Outcome

The patient remained stable through the subsequent course. Neurological deficits improved moderately.

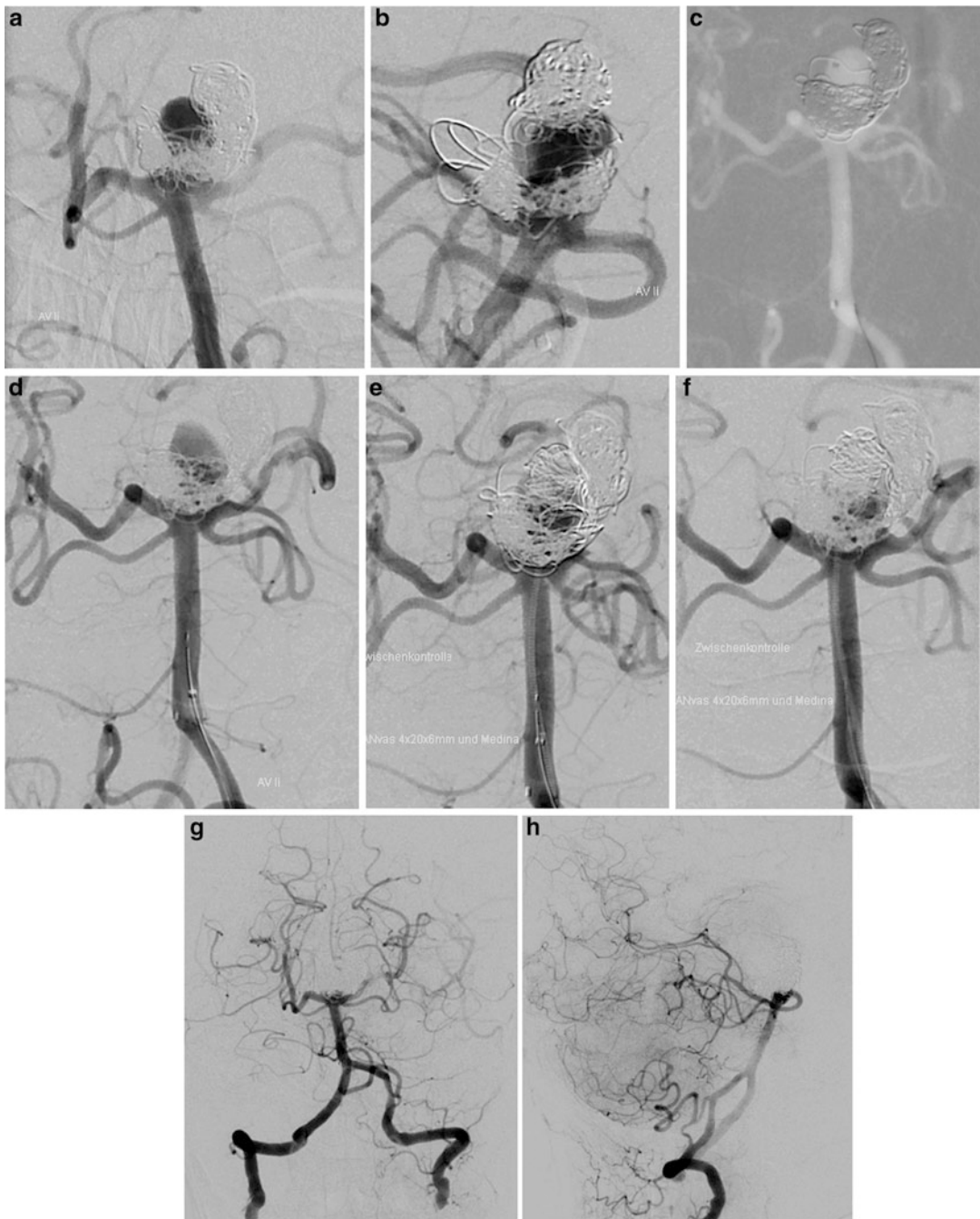


Fig. 6 DSA confirmed recurrence with central inflow and further displacement of the previously implanted coils ((a) PA view, (b) lateral view). The tip of a 0.027" ID microcatheter was placed in the aneurysm sac (c), the pCANVAS was advanced and the petals were deployed to be placed at the level of the neck ((d), markers are covered by coils). After catheterization of the aneurysm sac with a second

microcatheter, the aneurysm sac was occluded with 11 MEDs in total, until dense packing was reached (e, f). The final angiogram after detachment of the pCANVAS and removal of the microcatheters demonstrated a complete occlusion of the aneurysm and patency of both PCAs (g, h)

Follow-Up Examinations

A follow-up angiography was performed 6 months after the third treatment and did not show any inflow into the aneurysm sac (Fig. 7a, b). The MRI at the same time demonstrated a stable situation concerning the midbrain compression by the large and thrombosed aneurysm without surrounding edema (Fig. 7c, d).

Discussion

The endovascular treatment of wide-necked bifurcation aneurysms is challenging. Several approaches are available to stabilize the coils in the aneurysm sac and guarantee the patency of the bifurcation branches at the same time (Pierot and Biondi 2016). Before the introduction of dedicated bifurcation stents and intrasaccular flow

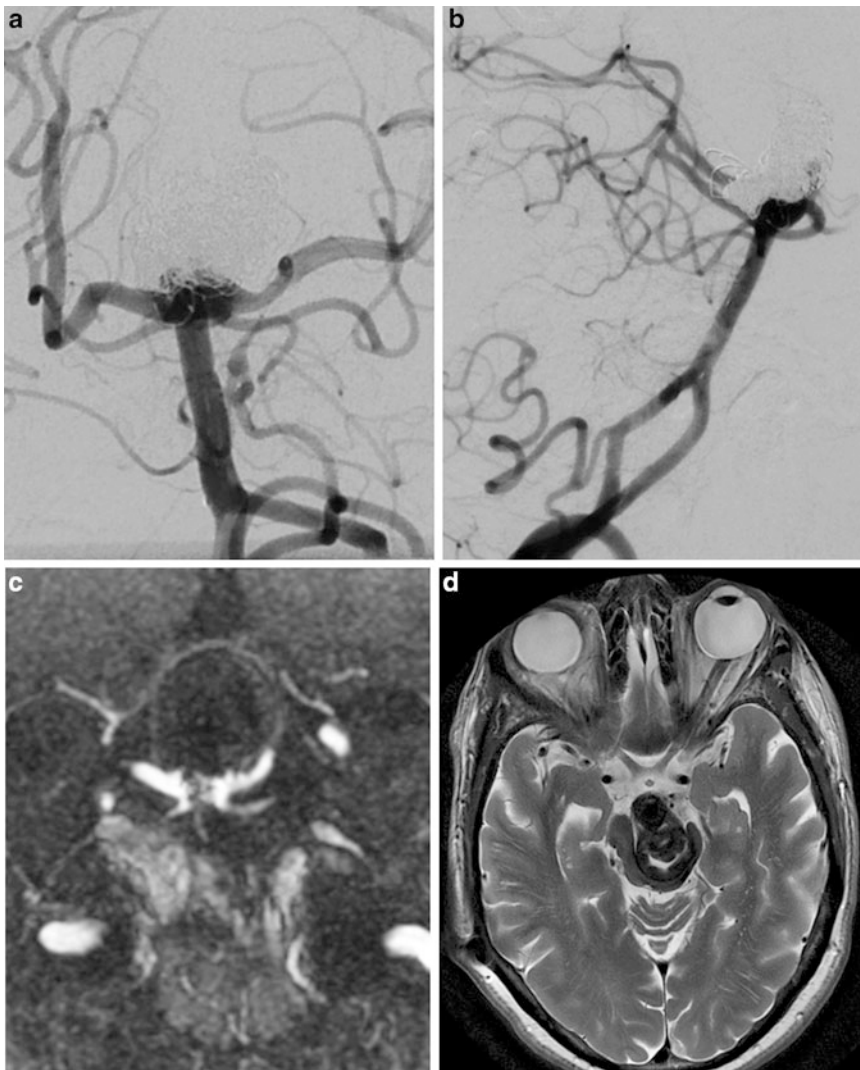


Fig. 7 Follow-up angiography at 6 months ((a) PA view, (b) lateral view) as well as MRI ((c) coronal MR-angiography) showed no aneurysm recurrence. Compression of

the brain stem was stable and there was no surrounding edema ((d) transverse T2WI)

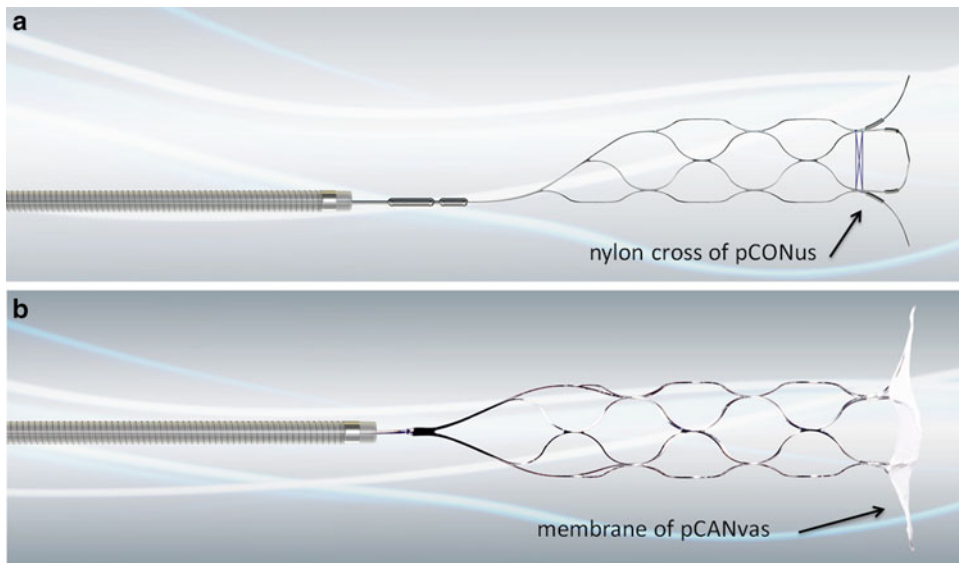


Fig. 8 pCONUS (a) and pCANVAS (b) (both phenox). The hemodynamic effect of pCANVAS is related to a thin

polymer membrane, which is covering the four distal petals of the implant

disruption devices, the *waffle cone* technique was used as an alternative to Y-stenting in selected cases. The technique incorporates placement of a self-expanding stent with its distal end directly within the base of a bifurcation aneurysm and subsequent coil occlusion through the expanded distal end of the stent, allowing for preservation of parent artery patency (Yang et al. 2008; Sychra et al. 2011; Horowitz et al. 2006). However, neither large series nor long-term results are available for this technique. Even more important, the straight distal end of said stents has only a very limited capacity for coil retention within the aneurysm sac and away from the vessel bifurcation.

Several years after the initially successful *waffle cone* treatment, our patient experienced massive aneurysm growth and developed severe clinical symptoms due to midbrain compression by the now, largely thrombosed giant aneurysm. Whether this process was triggered by a disadvantageous alteration of the blood flow after intra-aneurysmal stent deployment remains speculative. Hemodynamic studies with pCONUS (phenox), which is in this regard quite similar to a Solitaire stent used in a *waffle cone* fashion, did not show a detrimental redirection of blood flow toward the aneurysm (Pérez et al. 2016).

Recoiling of the aneurysm sac was technically feasible since the waffle cone Solitaire was still in place, but only resulted in a temporary occlusion of the aneurysm sac.

The endovascular concept of flow disruption is certainly promising in particular for treating complex and giant aneurysms. In our case, the initially used *waffle cone* stent deployment made various techniques (such as Y-stenting, as well as extra- or intrasaccular flow diverter implantation alone) technically impossible or at least unpredictable. The pCANVAS (phenox) offers the advantage of a bifurcation device with a hemodynamically active membrane, which directs the blood flow away from the aneurysm sac (Fig. 8).

Similar to the pCONUS (phenox), the pCANVAS (phenox) has four petals at the distal end which open outwardly when deployed at the level of the aneurysm neck. The petals are covered by a polymer membrane, which can be penetrated with any microguidewire/microcatheter combination which thereby allows for additional coiling (Henkes and Weber 2015, Pérez et al. 2016). The Medina Embolization Device (MED; Medtronic) is designed as a hybrid device combining features of a detachable coil and an intrasaccular flow disruption device (Henkes and Weber 2015,

Turk et al. 2016, Sourour et al. 2017). Stable occlusion results are reported in particular when it is combined with adjunctive devices (Aguilar Perez et al. 2017). In our case, the combination of MEDs together with the pCANVAS resulted in complete occlusion of the aneurysm sac immediately after the treatment and ongoing occlusion at 6 months thereafter. The clinical condition of our patient stabilized; however, she still suffers from the symptoms of midbrain compression.

Therapeutic Alternatives

pCONUS

PulseRider

Waffle Cone Stent Deployment

WEB

Y-stenting

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