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# Primary stenting as emergency therapy in acute basilar artery occlusion

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**Abstract** In three patients with acute occlusion of the basilar artery intra-arterial fibrinolysis resulted in only partial recanalization and revealed severe stenosis as the underlying cause. Application of micro-stents without previous dilatation resulted in vessel re-opening. Two patients had an excellent clinical outcome. One patient died 10 days after the stroke due to brainstem infarction. Emergency primary stent application may improve the outcome in acute basilar artery occlusion, if intra-arterial thrombolysis fails to re-establish a sufficient flow.

**Keywords** Intracranial stents · Basilar artery · Cerebral thrombosis

## Introduction

The prognosis for acute occlusion of the basilar artery (BA) is poor. Although local intra-arterial fibrinolysis (LIF) has been shown to improve the outcome [1], survival at 3 months is only approximately 35% [2]. If the occlusion is caused by local thrombus formation on a pre-existing severe stenosis, thrombolysis often fails to re-establish a sufficient flow. Recanalization has been shown to be one of the main factors influencing the prognosis: if the initial treatment fails to re-establish a sufficient flow the outcome almost inevitably will be fatal.

Only recently, due to the development of new catheter devices application of stents to intracranial vessels has been made possible. To our knowledge, up to now there are only three case reports [3, 4, 5] on stenting as emergency therapy in acute occlusion of the BA.

We present three cases with acute BA occlusions superimposed on severe mid-basilar stenoses. Application of stents without previous dilatation resulted in marked angiographic, hemodynamic, and clinical improvement.

## Case reports

Case report 1

A 53-year-old patient was admitted to the neurological intensive care unit because of progressive vertigo, repeated vomiting, dysarthria, tetraparesis and disturbance of consciousness (NIH stroke score: 17). The patient had longstanding arterial hypertension and diabetes mellitus without former history of cerebral ischemias. CT excluded a hemorrhage and showed a mild vascular encephalopathy without signs of an acute ischemia. Intra-arterial angiography performed 6 h after onset of symptoms revealed an occlusion of the BA distal to the origin of the anterior inferior cerebellar arteries (Fig. 1a). After intravenous application of heparin (bolus of 5,000 IU followed by 1,000 IU p.h.) a microcatheter was inserted coaxially into the left vertebral artery. LIF with a total of 60 mg rt-PA was performed at different catheter positions within and proximal to the thrombus. Angiographic control series revealed only transitory incomplete recanalization of the BA with re-occlusion despite ongoing lysis due to a severe mid-basilar stenosis

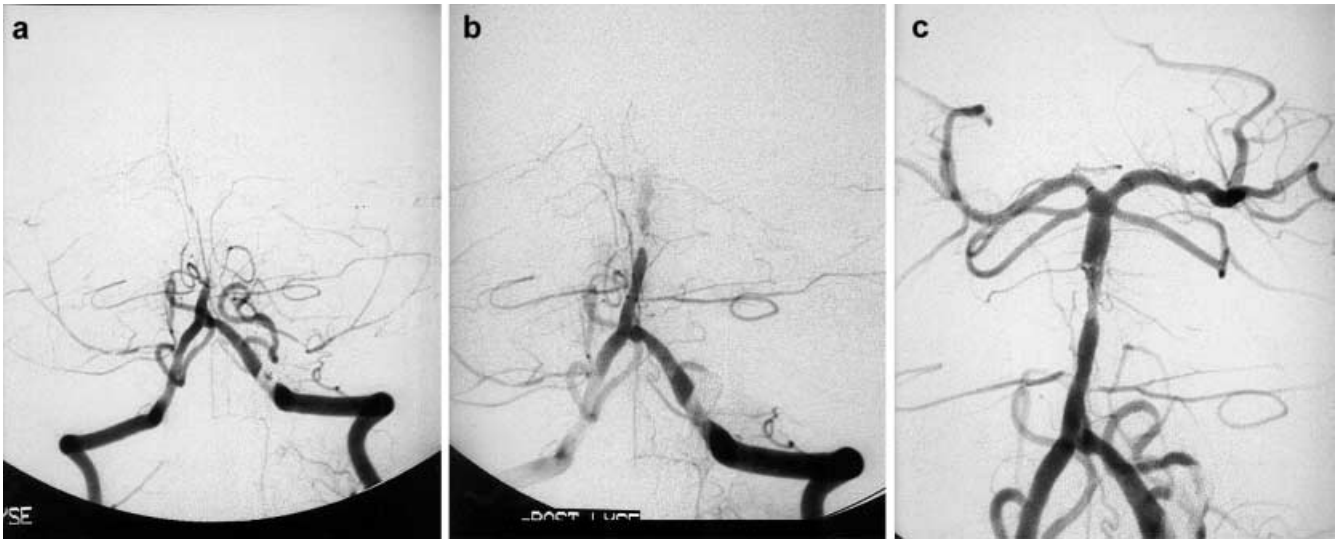


**Fig. 1a–c.** Patient 1. **a** Occlusion of the BA distal to the origin of the anterior inferior cerebellar arteries. **b** Control angiography after LIF reveals filiform mid-basilar stenosis. **c** Markedly improved perfusion with orthograde filling of both SCAs and PCAs after stent application. Note residual stenosis of the BA

located between the origins of the anterior inferior (AICA) and superior cerebellar arteries (SCA) (Fig. 1b).

Because permanent recanalization could not be achieved we decided to dilate the stenosis under stent protection. A stent (8-mm length, diameter 2 mm) mounted on a 3F deployment catheter (Medtronic, Arterial Vascular Engineering, Santa Rosa, Calif.) was inserted coaxially, positioned within the stenosis and dilated. Control angiography revealed a remaining stenosis of approximately 40% in the stented segment, but a markedly improved perfusion of the BA with orthograde filling of both SCAs and posterior cerebral arteries (PCA) (Fig. 1c).

Because of pneumonia the patient remained intubated for 3 days. After extubation he was conscious and fully oriented, and presented moderate dysarthria, dysphagia, hemianopia to the right, and right-sided sensorimotor paresis with increased reflex responses. MRI performed 4 days after stenting showed ischemic areas in the left cerebral peduncle, left cerebellum, and in the territory of the left PCA. MR angiography revealed normal flow proximal and distal to the stent, but no flow signal could be detected within the stent due to artifacts. Transcranial duplex sonography showed orthograde flow in the BA. For secondary prophylaxis the patient received a combination of clopidogrel and aspirin. Fourteen months after the intervention the patient presented an NIH stroke score of 6.

## Case report 2

A 60-year-old man with a longstanding history of arterial hypertension, coronary insufficiency, and myocardial infarction was admitted to the neurological intensive care unit with an 8 h symptomatology of cold sweating, severe dysarthria, dysphagia, hemiparesis on the right, extension of the extremities on pain stimulation, and intermittent disturbances of the consciousness (NIH stroke score: 15).

The initial CT was normal apart from an old lacunar infarction in the posterior limb of the right internal capsule. Angiography showed an occlusion of the BA distal to the origin of the AICAs. Both PCAs and the distal BA were filled from the internal carotid arteries via the posterior communicating arteries with fresh thrombus material in the basilar tip. There were severe generalized arteriosclerotic lesions in all major intracranial vessels. Heparin was applied intravenously. LIF within and proximal to the thrombus with a total of 60 mg rt-PA resulted in only partial recanalization and revealed a circumscribed stenosis of the BA between the origins of the AICAs and the SCAs. Coaxial insertion and primary (without previous balloon angioplasty) dilatation of an 8-mm long stent with a diameter of 3 mm (Medtronic) resulted in markedly improved perfusion of the BA with orthograde filling of both SCAs and PCAs. There was a residual stenosis of approximately 20% at the proximal end of the stent.

MRI revealed a small infarction in the pons. MR angiography documented flow in the BA distal to the stent. Within the stent there was no detectable flow signal due to artifacts. Orthograde flow within the BA was documented by transcranial duplex sonography.

Fourteen months after the intervention the patient showed mild dysarthria and moderate spastic hemiparesis of the right side (NIH stroke score: 6). Because of severe generalized atherosclerotic lesions of all cerebral arteries the patient received a combination of warfarin and clopidogrel as secondary prophylaxis.

## Case report 3

A 76-year-old woman was admitted to hospital because of progressive disturbances of consciousness and tetraparesis (NIH stroke score: 17). She suffered from longstanding arterial hypertension, diabetes mellitus, and myocardial insufficiency.

CT excluded an intracranial hemorrhage and infarction. Angiography showed occlusion of the BA distal to the origin of the AICAs (Fig. 2a). After intravenous application of heparin LIF was performed with a total of 50 mg rTPA and resulted in the reopening of only a short part of the middle BA (Fig. 2b). The distal BA remained occluded due to a severe stenosis. Therefore a stent (8-mm length, diameter 3 mm; Medtronic) was inserted without previous dilatation, resulting in marked angiographic improvement with orthograde filling of the basilar tip (Fig. 2c, d). There was no residual stenosis. After the intervention the patient received clopidogrel and aspirin intravenously. Clinically, the patient remained comatose. MRI performed on day 6 after the stroke showed infarctions of the pons and mesencephalon (Fig. 2e, f). The patient died 10 days later.

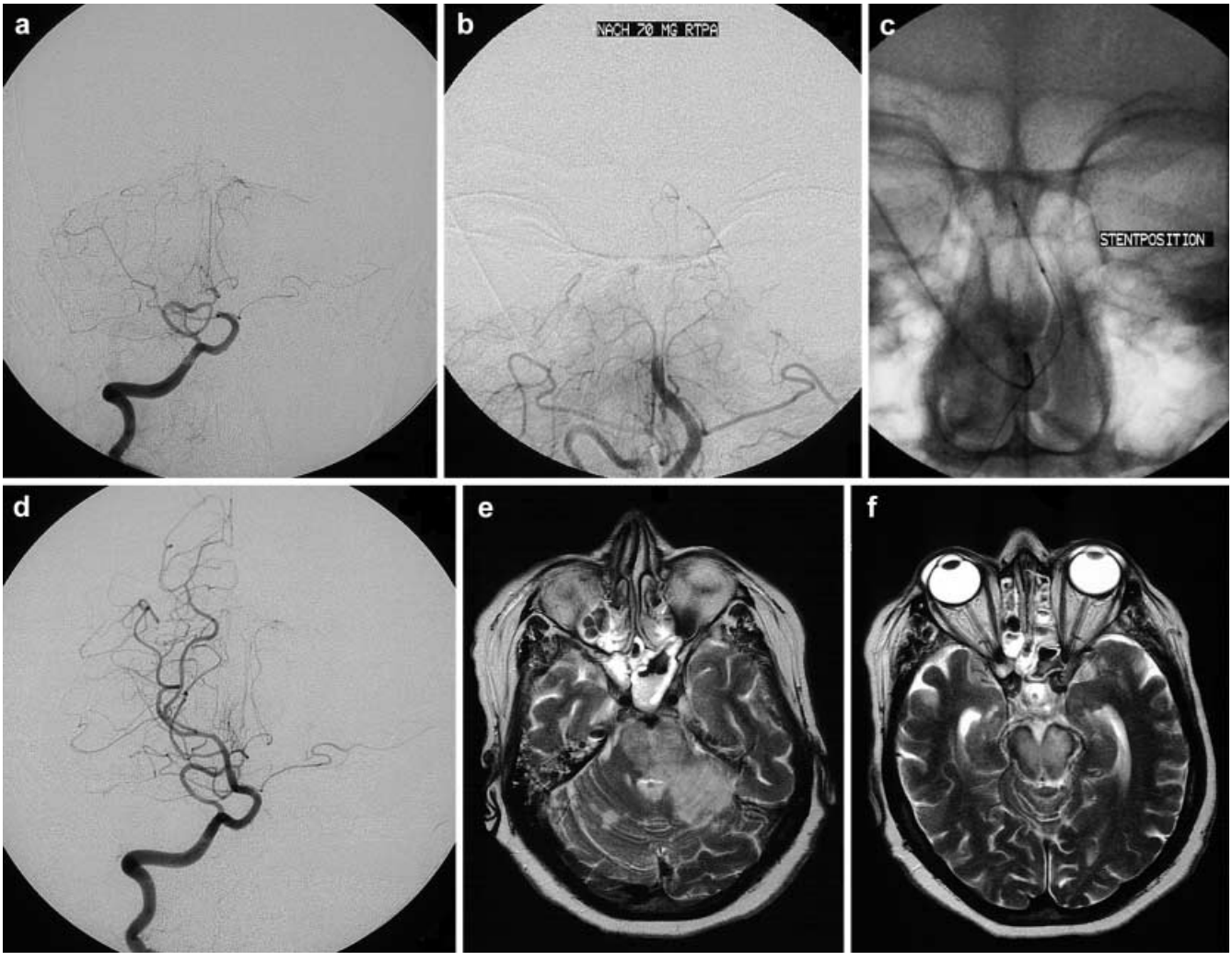


**Fig. 2a–f.** Patient 3. **a** Occlusion of the middle BA. **b** Reopening of a short stump of the BA after LIF with 50 mg rt-PA, persisting occlusion of the distal BA. **c** Positioning of the stent. **d** Result after stent application. **e**, **f** MRI shows extensive infarctions of the pons and mesencephalon (6 days after stroke)

## Discussion

We report three cases of stent application in acute occlusions of the BA caused by thrombosis on pre-existing severe mid-basilar stenoses.

In contrast to acute occlusions of the distal third of the BA, which are predominantly embolic in origin [2], occlusions of the proximal and middle third of the BA in the majority of cases are caused by thrombus formation on pre-existing atherosclerotic stenoses [6, 7]. Accordingly, the rate of recanalization by thrombolysis, as well as the percentage of survivors, is significantly lower in acute proximal and middle than distal basilar occlusions [2]. If intra-arterial thrombolysis fails to recanalize the basilar trunk, the outcome is almost invariably fatal [2, 8]. Thus, additional procedures which re-establish a sufficient flow are mandatory to improve the prognosis.

Percutaneous transluminal angioplasty (PTA) of the BA has been performed successfully by several groups [9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19]. However, PTA is compromised by the risk of dissection, vessel rupture, elastic recoil, distal embolization, and occlusion of perforators [11, 14, 20, 21] and has only minor effects on the lumen diameter of intracranial stenoses [15, 18].

Stent-protected dilatation has been shown to reduce the risk of fatal complications in numerous extracranial vessels. However, until recently, its application in intracranial vessels was not possible due to technical limitations.

With the development of small flexible endovascular devices, application of stents to the tortuous proximal intracranial vasculature has been made possible. Several reports on successful stent application in the BA have been published [3, 4, 5, 22, 23, 24, 25, 26, 27, 28, 29, 30].

However, most of these interventions have been performed electively in patients with symptomatic BA stenoses refractory to medical therapy.

There are only few reports on stent application as rescue therapy in acute BA occlusion. Malek et al. [3] successfully stented an iatrogenic dissection of the BA which was induced by PTA. In the cases reported by Phatouros et al. [4] and Callahan and Berger [5] intraarterial thrombolysis revealed severe basilar stenosis as the underlying cause of the basilar occlusion. The stenoses were successfully recanalized by stent application, but only after insufficient attempts had been made to reestablish flow by PTA. We decided to apply the stents without previous dilatation to decrease the risk of distal embolism and dissection by the initial unprotected balloon dilatation and to reduce the time until successful reperfusion. This procedure may improve the chance for neurological recovery.

Overdilatation increases the risk of vessel rupture and occlusion of perforators [13]. Therefore, we used stents with a diameter slightly smaller than the original vessel lumen and accepted restenoses of 40% (case 1) and 20% (case 2). In accordance with Nakatsuka et al. [13] we believe that the hemodynamic effect of the angioplasty has more impact on the outcome than a perfect "morphological cure".

The optimal additional medical therapy in intracranial stenting is still under debate. During the procedure all our patients received heparin. In the acute stage triple therapy with heparin, aspirin, and clopidogrel was applied. For secondary prophylaxis one of our patients received clopidogrel and aspirin; another patient with severe generalized arteriosclerotic stenoses was treated with warfarin and clopidogrel. Further studies are mandatory to ascertain the optimal medical regimen in intracranial stenting. Additional application of platelet glycoprotein IIb/IIIa inhibitors may further improve the prognosis [31].

Dilatation of the BA with and without stent application inevitably carries the risk of occluding small pontine branches. This risk might be even higher in stent-protected dilatation, since the struts of the stent may permanently occlude the orifices of basilar perforators. However, Waakloh et al. [32] have shown that small branches of the internal carotid artery of dogs (roughly resembling BA perforators in humans) tend to remain patent, if less than 50% of the ostium is covered by the stent struts. In view of the devastating spontaneous prognosis of acute basilar thrombosis the risk of occlusion of perforators seems to be acceptable.

However, data concerning long-term patency and restenosis due to neointimal proliferation in intracranial stents are still lacking. The long-term benefit of stenting of the BA has to be proven by clinical and neurovascular follow-up examinations.

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