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Carotid angioplasty with stenting for chronic internal carotid artery occlusion: technical note

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Abstract
Introduction Carotid angioplasty with stenting (CAS) is becoming accepted as an effective and reliable treatment option for severe carotid artery stenosis. However, it is rarely applied for carotid occlusion, especially in its chronic stage. We report our experience of CAS for chronic internal carotid artery occlusion representing compromised cerebral blood flow using various protection methods.
Methods A 77-year-old woman, who was already diagnosed with severe left internal carotid artery stenosis, suddenly had right hemiparesis and aphasia. At that time, she was treated conservatively because her neurological status was quite good, in spite of left carotid artery occlusion. Her symptoms improved in the short term, except slight aphasia, but deteriorated again 18 days from the onset, and magnetic resonance imaging (MRI) showed new ischemic lesions. CAS was then performed for the occluded carotid artery on the 23rd day from the first onset.
Results Using the proximal protection technique, the occluded lesion was crossed carefully with a microguidewire. Stents were also placed successfully with the distal protection technique. The occluded carotid artery was completely recanalized without any unfavorable events or neurological deterioration.
Conclusion In this patient, CAS was successfully to treat chronic carotid artery occlusion. These procedures and techniques are reviewed and discussed.

Keywords Carotid angioplasty with stenting (CAS) · Carotid artery occlusion · Protection method

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Introduction

Carotid angioplasty with stenting (CAS) is nowadays recognized as a useful modality for severe carotid artery stenosis as well as carotid endarterectomy [1, 2]. Although it is indeed a useful method, it is rarely performed for carotid artery occlusion except for neurological rescue in the hyperacute phase just after the occlusion [3]. We report the case of a patient with progressive stroke due to chronic carotid artery occlusion who was treated with CAS, resulting in successful recanalization and an excellent outcome. In this paper we report our experience from the technical point of view.

Case presentation

A 77-year-old female, who had suffered left amaurosis fugax, was diagnosed with severe left internal cervical carotid artery (ICA) stenosis and external carotid artery (ECA) occlusion (Fig. 1). Single photon emission tomography (SPECT) showed severely compromised cerebral blood flow (CBF). Although cerebral angiography and further treatments were recommended at this point, she refused further examination.

Three days later, she was brought to our emergency room suffering from mild right hemiparesis and dysphasia.

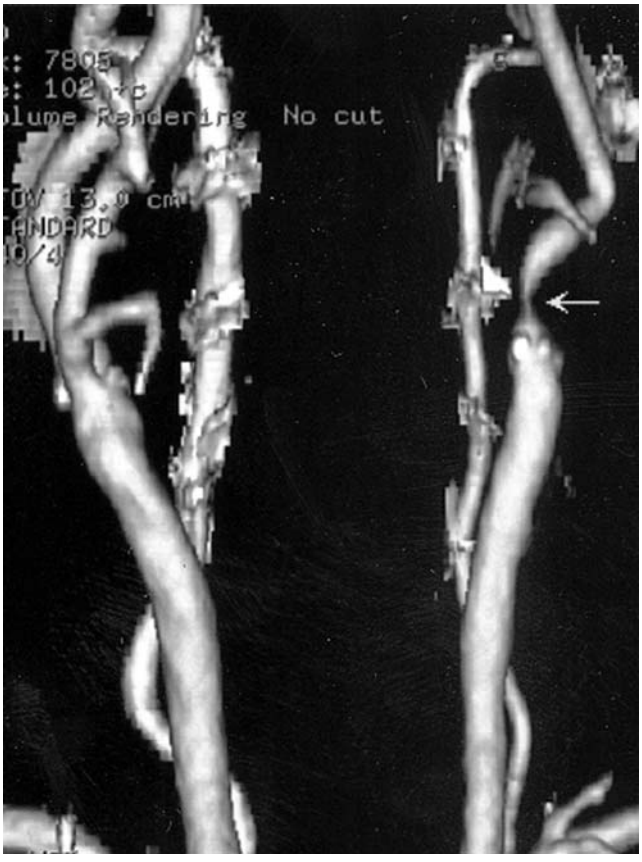

Fig. 1 Three-dimensional MR angiography shows left ICA stenosis (*arrow*) and ECA occlusion

Her National Institute of Health Stroke Scale (NIHSS) [4] score was 6. An emergency CT scan showed no apparent early ischemic signs, but MR imaging showed am area of high signal in the left middle cerebral artery region on diffusion-weighted images (DWI), and her left ICA was not seen on MR angiography (Fig. 2a,b). The angiogram acquired soon after onset revealed complete occlusion of the common carotid artery (CCA) at the level of the second thoracic vertebra (Fig. 2c).

At this stage, we did not consider early recanalization because of the irreversible broad ischemic area revealed on DWI, and opted for medical therapy including hemodilution and antiplatelet drugs. Her symptoms gradually resolved and improved to fully independent activity of daily living. However, 18 days after the onset, she suddenly suffered aphasia again, and a DWI study showed new ischemic lesions in the left watershed area (Fig. 3a). As the progressive ischemic symptoms were considered to be due to hemodynamic compromise, we decided on carotid recanalization using endovascular intervention.

Techniques

We already had information about the location of the stenotic lesion, which was at the level of fourth cervical vertebra in the initial angiogram. Further, three-dimensional CT angiography after the onset showed that the distal ICA was patent at least at the level of the second cervical vertebra (Fig. 3b). Therefore, we considered that angioplasty would be possible within the cervical area, but not intracranially.

A 9F balloon catheter (Patrieve, Clinical Supply, Gifu, Japan) as the guiding catheter was navigated into the CCA, and the balloon was inflated sufficiently for proximal protection. In this condition, the lesion was crossed with a guidwire (GT wire 0.016-45; Terumo Corporation, Tokyo, Japan) and microcatheter (Transit II, Cordis Neurovascular), and the patency of the distal part of the ICA was confirmed (Fig. 4a).

Under inflation of the proximal balloon, angioplasty was performed with a balloon catheter (Amiia, Cordis Neurovascular) and the stent (Protage, EV3) was placed. The stent seemed to be open widely enough. Then, the distal protection balloon (Percusurge Guardwire, Medtronic) was navigated distal to the stent and inflated. Under distal protection, the proximal balloon was deflated and the aspiration catheter (Thrombaster, Kaneka Medics, Osaka, Japan) was navigated just beneath the distal balloon. A

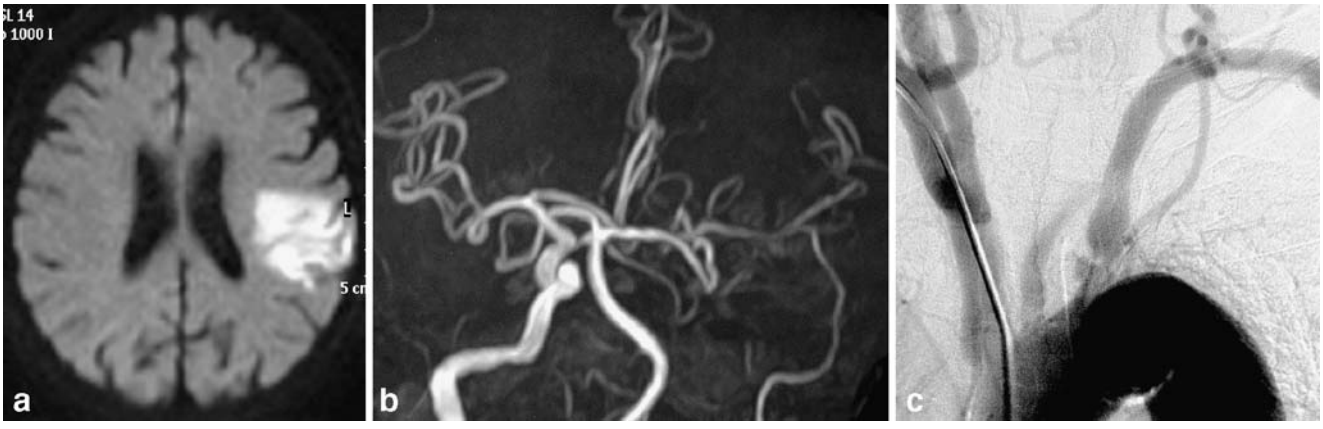

Fig. 2 High-intensity area in the middle cerebral artery region is revealed on DWI obtained on admission (**a**). The left ICA is not seen on MR angiography (**b**). Occlusion of the CCA is seen on the angiogram (**c**)

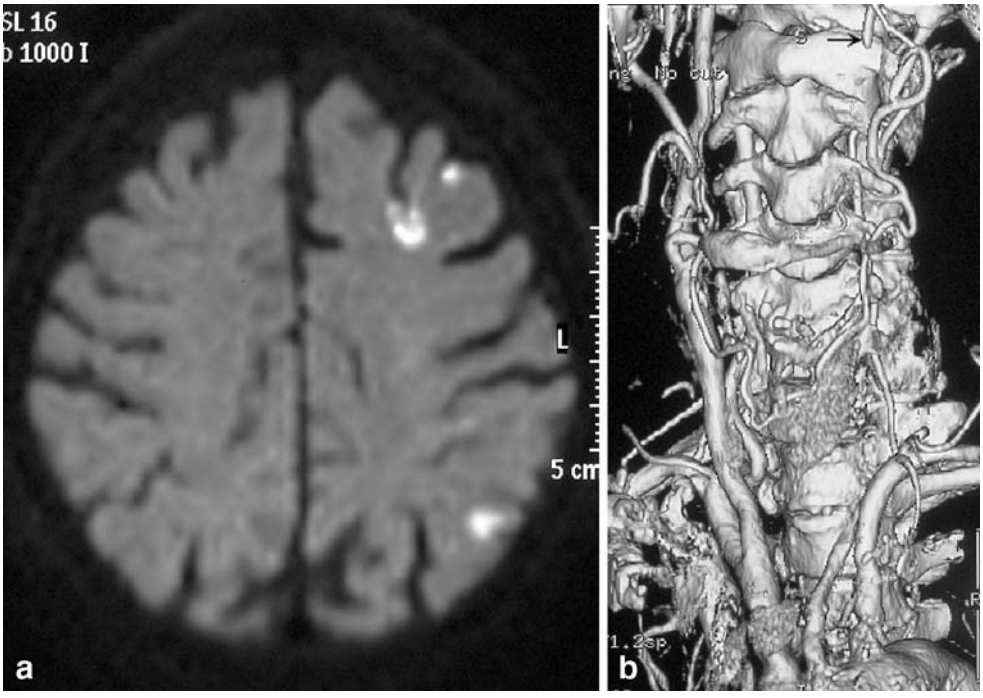

Fig. 3 DWI obtained soon after the second ischemic attack shows new high-intensity lesions in the watershed area of the left hemisphere (**a**). The distal end of occluded lesion is seen on 3D-CT angiography (**b**). The distal part of the ICA is opacified and visualized (*arrow*) in this study

retrograde angiogram with a small amount of contrast material injected through the aspiration catheter showed a large contrast defect in the CCA proximal to the stent (Fig. 4b). This finding was considered to represent a remaining mural thrombus, plaque shift or intimal dissection caused by stenting. Therefore, another stent (Protage,

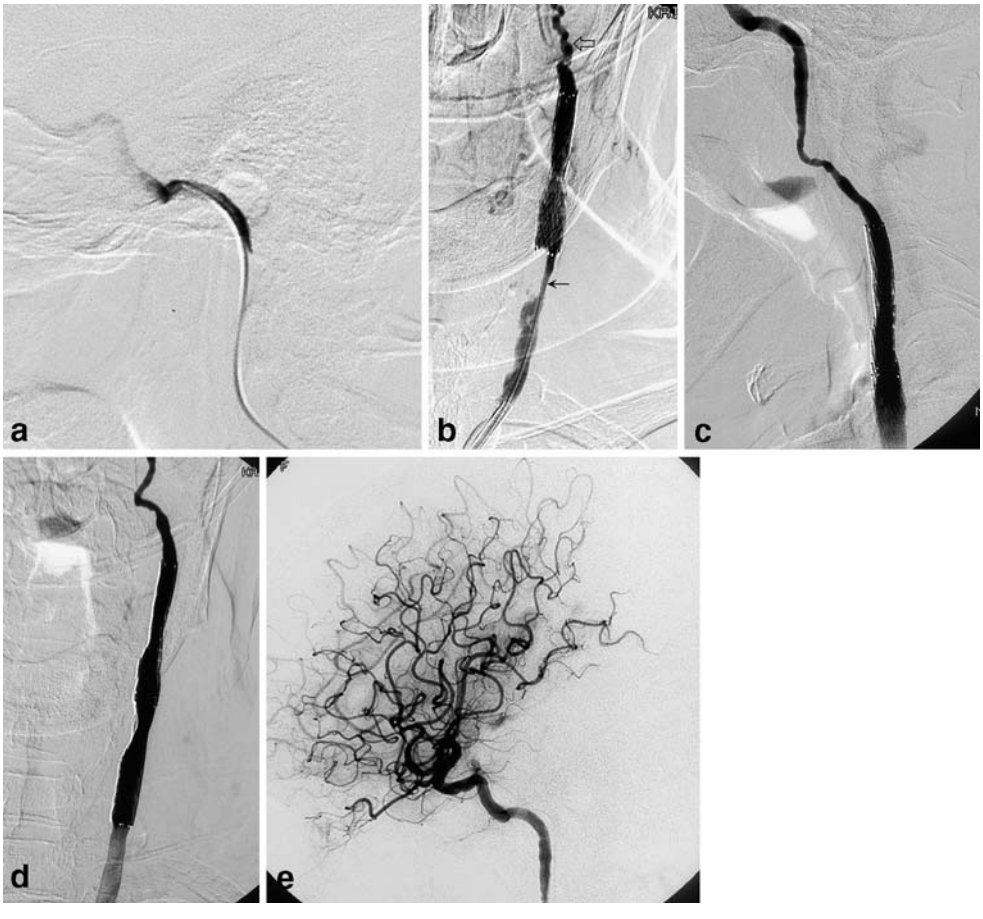

Fig. 4 Patency of the distal part of the ICA above and around C2 is shown on superselective angiography (**a**). The severe stenotic lesion remains (**b**) in the region just proximal to the deployed stent (*arrow*), which was treated with another stent. Vasospasm is seen on the side distal from the stent as well (*open arrow*). Although mild vasospasm remains (**c**), the occlusion or stenosis is well-resolved (**d**), and intracranial blood flow is shown to be dramatically improved on angiography (**e**)

EV3) was deployed just proximal to the former stent in a telescoped fashion. Improvement of the stenosis and no in-stent thrombus were confirmed on the repeated angiogram under the distal protection. Then 40 ml of blood was aspirated, and the distal protection was released. The total balloon occlusion time was 26 min.

The final angiogram showed successful recanalization without stenosis and remarkable improvement of cerebral blood flow in spite of mild vasospasm (Fig. 4c–e). MR imaging showed no apparent new ischemic lesion on DWI after the procedure. The postoperative course was uneventful. She was managed in the intensive care unit for 2 days, then discharged 45 days later in a stable neurological state with a NIHSS score of 2 after rehabilitation.

Three-dimensional CT angiography and curved multiplanar reconstruction images taken 6 months later showed no in-stent restenosis and the recovery of vasospasm (Fig. 5). She fully recovered neurologically.

Discussion

Although angiographic recanalization for complete ICA occlusion is sometimes indicated for neurological or survival rescue in the acute stage [5, 6], in some instances, asymptomatic or neurologically stable patients with extracranial ICA occlusion basically have no indication for endovascular recanalization because the location and length of the stenotic lesion is unclear and there is a high risk of distal migration of thrombus on catheterization through the thrombus and stenting. Recently however, Terada et al. have reported its feasibility and efficacy [3]. Recanalization for symptomatic subclavian artery occlusion is generally justified even in the chronic stage, and some reports have indicated its efficacy [7, 8]. We treated our patient conservatively at first because her symptoms were not so severe at a NIHSS score of 6. However, the second stroke due to the ICA occlusion was considered progressive ischemia due to hemodynamic compromise and a high-risk state requiring revascularization. Only revascularization by direct recanalization was available because an extracranial–intracranial arterial bypass could not be adopted due to ECA occlusion. Therefore, we decided on direct angioplasty and stenting even though it was performed 18 days after occlusion.

In this patient, there were some specific and favorable factors. First, we had already acquired information on the stenotic lesion by three-dimensional CT angiography before its occlusion. Second, there was no collateral pathway via the ECA, which had been occluded in advance. Third, we were able to evaluate the patency of the distal ICA by three-dimensional CT angiography. From the technical point of view, the utmost care should be taken to avoid embolic complications due to the distal migration of thrombi. The movement of an unstable or fresh thrombus is likely to occur

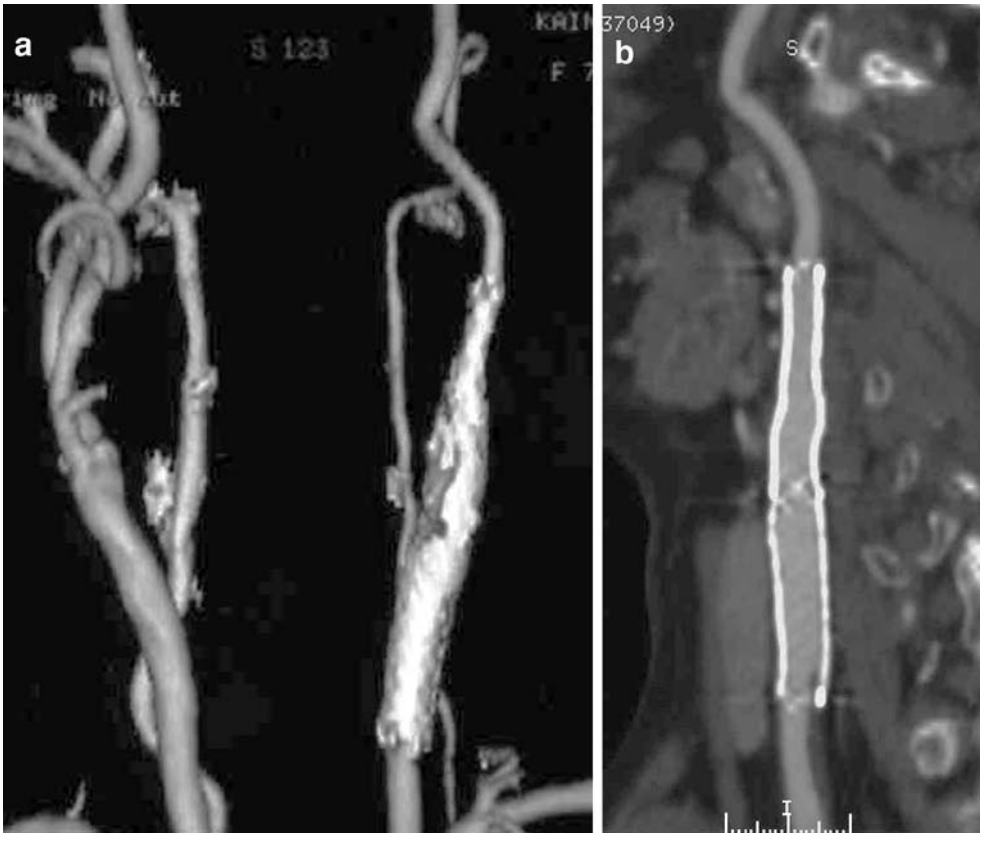

Fig. 5 Three-dimensional CT angiography performed about 10 months after the procedure shows that vasospasm just distal to the stents has clearly dissolved (**a**). Patency is very well established and restenosis is not observed (**b**)

in the lesion being crossing with the microguidewire [9]. To avoid this accident, a proximal protection method is essential [3]. Fortunately, there was no need for ECA protection in this patient. Thus, we were able to successfully place the microcatheter distal to the thrombus under the simple proximal protection. However, if the ECA opens unexpectedly due to the angioplasty maneuver, there is the risk of distal migration of the embolus due to the reversed flow from the ECA. Therefore, we placed the distal protection balloon system at a patent portion of the ICA, and achieved complete interruption of the carotid artery blood flow during the angioplasty and stenting. This is a variation of the triple protection method, the so-called "seatbelt and airbag technique" [10], which is the combination of proximal [11] and distal protection [12] techniques.

It is very useful to evacuate the blood including the thrombus and debris after the endovascular procedure, because we know the distal end of the thrombi which should be located at least below the distal protection balloon and can confirm shift of the remaining thrombus or plaque with a small injection of contrast agent after the proximal balloon is released without fear of embolic complications. Although complete protection with enough inflation of the distal balloon is the key to success, overinflation may cause vasospasm or dissection such as in our patient. As for treatment for any remaining thrombus, there are two alternatives; one is the use of thrombolytic agents to shrink it, and the other is direct angioplasty with the balloon or stents to press it against the carotid wall. In this instance, the mural thrombus was relatively large, and seemed to have a high risk of detaching and distal migration during fibrinolysis. We therefore selected another stent deployment, resulting in successful immobilization and compression of the thrombus.

The development of a protection system can serve to reduce the risk of embolic migration [10, 13]. Since crossing of the lesion under proximal protection is essential, the combination with distal balloon protection should be very useful and enhance safety. This case suggests the feasibility of recanalizing successfully even in chronic carotid occlusion. However, all maneuvers should be performed meticulously to avoid mechanical vascular trauma due to the blind approach and catheterization.

Conclusion

Since the efficacy of extracranial–intracranial arterial bypass is now under reevaluation [14–16], the treatment strategy for the chronic compromised CBF state resulting from carotid occlusion remains unclear. In this special case of a patient with no indication for bypass surgery, endovascular recanalization is the treatment choice and is a very effective and safe procedure when undertaken with the proper protective methods.

Conflict of interest statement We declare that we have no conflict of interest.

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