Protection of Anastomotic Pathways to the Vertebral Artery During Stenting of External Carotid Artery Stenosis
—Case Report—

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Abstract
A 61-year-old man presented with a severe external carotid artery (ECA) stenosis with concomitant ipsilateral internal carotid artery (ICA) occlusion manifesting as amaurosis fugax. The left ophthalmic artery was supplied from the left ECA. The left intracranial ICA was supplied by the collateral flow from the contralateral ICA and ipsilateral ECA through the ophthalmic artery. The left vertebral artery also participated in the latter collateral pathway through the left occipital artery and ascending pharyngeal artery. Percutaneous revascularization of the ECA was performed using a nitinol self-expanding stent. To prevent embolic complications through the ophthalmic or vertebral arteries, distal protection was performed using a balloon. During a 22-month follow-up period, the patient was completely free from any ocular or neurological symptoms. The present case of severe ECA stenosis with ipsilateral ICA occlusion showed that percutaneous balloon angioplasty with stenting is feasible and effective. This intervention requires cautious evaluation of the anastomotic pathways connecting the ECA to the cerebral circulation to avoid embolic complications.

Key words: amaurosis fugax, external carotid artery stenosis, stenting, distal protection

Introduction
Blood supply to the ocular region including the retina is usually provided by the ophthalmic artery, which branches from the internal carotid artery (ICA). The external carotid artery (ECA) may become important as a source of collateral blood supply not only to the brain but also to the retina during ipsilateral ICA occlusion. Therefore, occlusion of the ECA with concomitant ipsilateral ICA occlusion may cause ischemia of the brain or retina. Within the last decade, carotid artery stenting has been recognized as a potential alternative to endarterectomy for ICA stenosis, because of improvements in protection devices.9,23 Endovascular stenting for symptomatic ECA stenosis may have a similar benefit to endarterectomy with less surgical invasiveness.

We describe a case of ocular ischemia treated by stenting of the symptomatic ECA stenosis with ipsilateral ICA occlusion, and discuss the importance of the procedure used to protect against embolic events based on the characteristics of the ECA, which has many branches with potential anastomoses to the cerebral circulation.

Case Report
A 61-year-old man had a history of repeated syncopal attacks in 2000. Severe stenosis of the right ICA and occlusion of the left ICA were recognized as the causes of his symptoms, and carotid endarterectomy was performed on the right ICA. After the operation, he had been completely free of symptoms, and was treated with aspirin 100 mg/day. He presented with repeated transient monocular blindness affecting the left eye in December 2006. Magnetic resonance angiography demonstrated severe stenosis at the origin of the left ECA. Digital subtraction angiography confirmed the presence of severe stenosis (99%) at the origin of the left ECA, and the previous left ICA occlusion. The right ICA treated 6 years previously was patent with no significant restenosis. The left ophthalmic artery was retrogradely supplied from a peripheral branch of the left ECA. Retrograde collaterals were also identified from the left vertebral artery (VA), which supplied the left ECA via the left occipital (OA) and ascending pharyngeal arteries (APA). No lesions in the proximal part of the left VA were identified that might have acted as an embolic source. Therefore, we considered the stenosis at the origin of the left ECA to be responsible for the amaurosis fugax due to either hemodynamic insufficiency or embolism (Fig. 1). Fluorescein angiography of the left eye revealed delayed arterial filling and prolonged arteriovenous transit time.
The amaurosis recurred despite additional medication (cilostazol, 200 mg/day). Endovascular balloon angioplasty with stenting of the left ECA stenosis was planned, anticipating removal of the lesions that were obstructing flow and acting as a possible source of emboli.

An 8 F and a 5 F sheath introducer were placed in the right and left femoral arteries, respectively. Systemic anticoagulation was initiated by intravenous bolus administration of 5,000 U of heparin, and an activated coagulation time (ACT) of 268 seconds was achieved. An 8 F guiding catheter was introduced into the left common carotid artery via the right femoral sheath. A 4 F diagnostic catheter was placed in the left VA through the left femoral sheath. During the procedure, the contrast image from the left VA was used to accurately confirm the points at which the APA and OA originated from the left ECA, as the ECA derived collateral blood supply from the left VA in retrograde fashion through the APA and OA. We anticipated that the blood flow in the APA and OA might be converted to antegrade flow after successful dilation of the ECA stenosis. Consequently, embolic events should be prevented not only in the ICA territory and the retina through the ophthalmic artery, but also in the vertebro-basilar territory through the APA and OA. A PercuSurge GuardWire (Medtronic, Minneapolis, Minn., U.S.A.) was navigated into the ECA crossing the stenosis, and placed in a position proximal to the points of origin of the APA and OA. The distance between the origins of these arteries and the upper margin of the intended balloon/stent placement was 23 mm, barely enough to safely accommodate the protection balloon, the tip of the balloon angioplasty catheter (Gateway; Boston Scientific, Boston, Mass., U.S.A.), and the stent (Precise; Cordis, Miami, Fla., U.S.A.). Prior to the operation, we measured the length of the component of these devices using one sample for each device. The distance between the equator of the protection balloon of the GuardWire and the proximal edge of its stopper was 5.5
The length of the tip of the angioplasty balloon (Gateway) and the stent (Precise) were 9 mm and 13.5 mm, respectively (Fig. 2). Using a 4 mm × 12 mm angioplasty balloon (Gateway), predilation (6 atm, 30 sec) was performed. An 8 mm × 30 mm stent (Precise) was successfully deployed, and postdilation (12 atm, 6 sec) was carried out with a 4 mm × 12 mm angioplasty balloon (Gateway) using the distal protection. After evacuating 40 ml of blood from the ECA just proximal to the protection balloon, and confirming absence of apparent debris in the blood, the distal protection balloon was deflated. Final angiography showed adequate dilation of the stenosis, and antegrade blood flow in the APA and OA (Fig. 3). Magnetic resonance imaging one day after the operation could not identify any new infarction in the brain including the vertebro-basilar territory. Fluorescein angiography also showed normalized blood flow in the left eye.

The patient has not had any further episodes of ocular ischemia during a 22-month follow-up period, and ultrasonography at 22 months confirmed satisfactory stent patency (Fig. 4).

Discussion

Visual disturbance secondary to carotid atherosclerotic disease is due to retinal embolic events originating from ICA stenosis in the majority of cases. Under physiological conditions, most of the ocular arterial blood supply is delivered from the ICA via the opthalmic artery. However, the ECA can be an important source of blood supply to the eye in the unusual situation of ipsilateral ICA occlusion. The ECA has many potential anastomoses to the ICA and VA, including an anastomosis to the ICA via the opthalmic artery. There are many arterial connections between branches of the opthalmic artery and peripheral branches of the ECA, such as the superficial temporal artery, the middle meningeal artery, and the ethmoidal artery from the internal maxillary artery. These connections increase in importance as a source of the collateral blood supply to the brain and the retina when the ICA is occluded. Concomitant stenosis of the ECA and occlusion of the ICA can easily cause ischemia not only in the brain but also in the retina, due to hemodynamic insufficiency or embolism. Many previous reports have confirmed the pathogenic condition of monocular ischemia due to advanced carotid occlusive disease involving both the ICA and ECA.3,4,7,11–14,16,18,24)

External carotid endarterectomy is the most common treatment for these lesions. The effectiveness of external carotid endarterectomy for patients with occluded ICA and ipsilateral ECA stenosis was first established in the 1960s, since when a number of reports have documented the efficacy of external carotid endarterectomy.2,3,5,10,15,17,19,21,26 whereas peri-procedural risk has been controversial. External carotid endarterectomy as an isolated procedure carries a low risk, but high mortality and morbidity occur in patients with diffuse concomitant atherosclerotic disease requiring complex procedures (i.e., reoperation, venous bypass grafts, or subsequent extracranial-intracranial bypass).8,10,17) Previously reported cases of endovascular repair of the ECA stenosis are limited. Three cases of successful ECA balloon angioplasty were performed prior to superficial temporal-middle cerebral artery bypass for ICA occlusion in 1982.23) Several cases of successful stenting for ECA stenosis have been reported since 2003.1,14,16,18,22,24) Currently, stenting of ICA stenosis is recognized as an alternative to carotid endarterectomy, especially in patients at high surgical risk.9,20)

Endovascular stenting for ECA stenosis will presumably improve any hemodynamic insufficiency and prevent emboli as for ICA stenosis. Nine cases of stenting of ECA stenosis due to atherosclerosis have been reported, including our case (Table 1). Eight of the nine cases were treated with the combination of ECA stenosis and ipsilateral ICA occlusion. The other case was treated with ICA occlusion, with a stump that seemed to be an embolic source.14) Three of the nine cases presented with neurological deficit, either complete stroke or transient ischemic attack. The other six cases presented with amaurosis fugax. The type of stent used varied from case to case. These cases showed relatively long-term stent patency. Only two cases were treated with distal protection using a filter device for the prevention of embolic events during the procedure.19,22) Endoluminal repair of atherosclerotic stenosis of the ECA must carry a high risk of releasing emboli from the voluminous plaque that already occupies the whole lumen of the occluded ICA. The “stump” of the occluded ICA is considered to be the cause of the embolisms. Many anastomotic pathways between the ECA and intracranial cerebral circulation that are sufficiently dilated after concomitant ICA occlusion will become routes for emboli to pass into the brain. These conditions strongly require methods of protection of the brain and eye from emboli. In these circumstances, we should at least examine carefully the bilateral carotid and ipsilateral vertebral angiograms, to identify anastomoses between the vascular territories. As seen in the present case, if the APA or OA carry collateral blood flow retrogradely to the ECA from the VA, we cannot identify these arteries without vertebral angiography. Without sufficient protection proximal to the branching points of the APA and OA, reversal of the blood

Fig. 4 Ultrasonogram confirming the good patency of the stent implanted into the external carotid artery (ECA) stenosis 22 months after the operation. CCA: common carotid artery, IJV: internal jugular vein.
flow in these arteries just after dilation of the ECA stenosis must pose the risk of carrying the debris into the vertebrobasilar territory. These arteries usually originate from the proximal part of the ECA. It is essential to identify the exact points of origin of these arteries, and to simulate prior to the actual operation whether the distance between the branching point of the APA or OA and the site where the upper margin of the stent will be positioned is long enough to allow placement of protection devices.

Endovascular stenting was successfully used to treat a case of atherosclerotic ECA stenosis with ipsilateral ICA occlusion that manifested as ocular ischemia. Careful evaluation of anastomoses between the ECA and the cerebral circulation is required, so that appropriate protection procedure can be used to prevent embolic events, because these anastomoses may serve not only as collateral pathways, but also as potential routes for emboli in the particular situation of ipsilateral ICA occlusion. The present case suggests that endovascular stenting using distal protection is a feasible, effective, safe, and less invasive therapeutic choice for symptomatic ECA stenosis with an acceptable period of stent patency.

References

ECA Stenting With Distal Protection


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