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Technique

Percutaneous angioplasty of a chronic total occlusion of the intracranial internal carotid artery. Case report

Masaki Komiyama, MD*, Masaki Yoshimura, MD, Yuji Honnda, MD
Yasuhiro Matsusaka, MD, Toshihiro Yasui, MD

Department of Neurosurgery, Osaka City General Hospital, Osaka 534-0021, Japan

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Abstract

Background: A CTO of the intracranial ICA is usually managed medically and rarely by EC-IC bypass in selected patients. Percutaneous transluminal angioplasty has not been used.

Case Description: A 73-year-old man presented with frequent temporary blindness of the left eye and dizziness due to thrombotic occlusion of the left intracranial ICA, causing hemodynamic compromise. This patient was successfully treated by percutaneous angioplasty (balloon angioplasty and stent placement) under proximal balloon protection at 7 weeks from the ictus. Ischemic symptoms had not recurred during the 6-month follow-up period.

Conclusion: Percutaneous angioplasty for a CTO of the intracranial ICA is technically feasible and can be an alternative to EC-IC bypass in a selected group of patients with symptomatic hemodynamic compromise, which is refractory to the best medical treatment.

Keywords: Chronic total occlusion; Internal carotid artery; Percutaneous angioplasty; Stenting

1. Introduction

Acute thrombotic occlusion of the cervical ICA has been occasionally managed by carotid endarterectomy or percutaneous transluminal angioplasty [4,7,9,10,14,18,22,23]. However, a CTO of the intracranial ICA is usually managed medically and rarely by EC-IC bypass in a selected group of patients [12]. To our knowledge, there have been no reports of revascularization of a CTO of the intracranial ICA by percutaneous angioplasty. Herein, we report a symptomatic patient with CTO of the intracranial ICA, which was successfully revascularized by percutaneous angioplasty.

2. Case report

2.1. History

A 73-year-old man presented with dizziness and loss of consciousness when he stood up, and was hospitalized. At admission, the patient was alert and well oriented, and no neurologic deficits were observed. Blood pressure was 145/88 mm Hg. He had undergone total gastrectomy for early gastric cancer half a year before this admission. Diabetes mellitus and hypertension were medically controlled for 10 years. Initial suspicion of hypoglycemia was rejected by a serum blood glucose level of 284 mg at admission. The remaining laboratory data were not contributory. During hospitalization, the patient felt that his antihypertensive drug caused dizziness; thus, the drug was withheld. This resulted in decreased frequency of dizziness. Every morning, he experienced temporary blindness of the left eye when he awoke and walked to the dinning room for breakfast, which disappeared when he sat there for about 10 minutes. This ophthalmic symptom did not occur at other times during the day. He experienced dizziness repeatedly when he stood up.

2.2. Preintervention evaluation

Ophthalmologic examination including funduscopy was normal. There was no venous stasis retinopathy. Temporary blindness occurring every morning was thought to be a transient ocular ischemia due to systemic postural hypotension. Magnetic resonance imaging of the brain showed

Abbreviations: CTO, chronic total occlusion; EC-IC, extracranial-intracranial; ICA, internal carotid artery; MR, magnetic resonance.

* Corresponding author. Tel.: +81 6 6929 1221; fax: +81 6 6929 1091.
E-mail address: komiyama@japan-mail.com (M. Komiyama).

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bilateral chronic ischemic changes and small cerebral infarcts in the left centrum semiovale. Magnetic resonance angiography demonstrated occlusion of the left ICA and marked atherosclerotic changes (multiple stenoses) of the right intracranial ICA. Antiplatelet therapy (100 mg of aspirin and 200 mg of ticlopidine daily) was started. A cerebral blood flow study showed slightly decreased blood flow at rest and moderately impaired response to acetazolamide challenge in the left hemisphere. Diagnostic cerebral angiography demonstrated a total occlusion of the left ICA and collateral flow through the left ophthalmic artery to the left middle cerebral artery (Fig. 1). The left cervical ICA had a taper occlusion (level formation of the contrast material) at the bifurcation even in the late phase, indicating the absence of a stenotic lesion. The right intracranial ICA had marked atherosclerotic changes with multiple stenoses at segments C2 through C5 (Fig. 2). The occlusion site of the left ICA was not apparent from angiography, but marked atherosclerotic changes of the left ICA, similar to those of the right ICA, were expected. The left anterior cerebral arterial territory was supplied by collateral flow through the anterior communicating artery. There was no discernible left posterior communicating artery. Moderate leptomeningeal collateral flow from the left posterior cerebral artery to the left temporo-parieto-occipital region was observed.

The diagnosis was a CTO of the left intracranial ICA, causing occasional hemodynamic ischemia of the left eye and cerebral hemisphere. The second syncope occurred 6 weeks after the ictus, but no focal neurologic signs including hemiparesis or aphasia were observed. The patient was recommended bed rest until a definite treatment was undertaken. He no longer experienced temporary blindness of the left eye, dizziness, or syncope. Angioplasty to the right intracranial ICA was risky and not realistic because the stenoses were multiple and the lesion was too long and markedly tortuous. Therefore, we proposed to the patient and his family the common management of left EC-IC bypass surgery as well as the percutaneous angioplasty of the occluded intracranial ICA. They consented to the angioplasty and agreed that in case of revascularization failure, EC-IC bypass surgery would then be selected.

A B

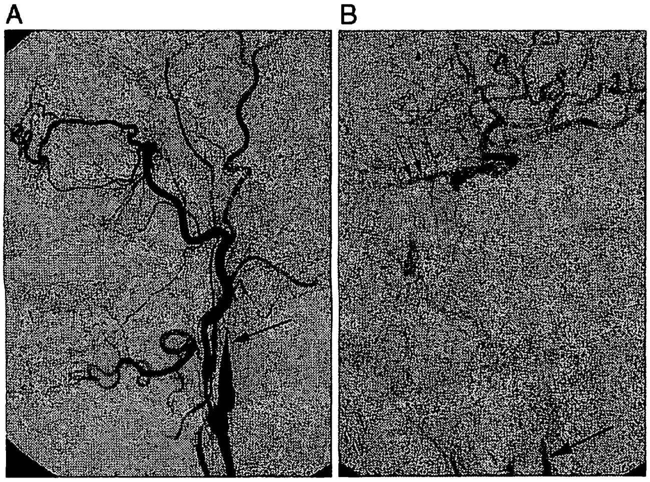

Fig. 1. Left common carotid arteriograms (A: early arterial phase, B: late arterial phase, lateral views) showing the tapered occlusion at the cervical bifurcation (single arrows) and the distal ICA through the ophthalmic anastomosis (double arrows).

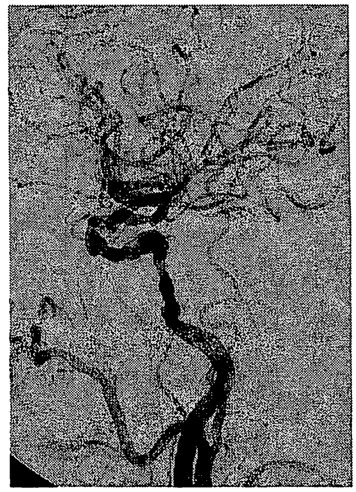

Fig. 2. Right common carotid angiogram (lateral view) showing marked atherosclerotic changes and multiple stenoses of the intracranial ICA.

2.3. Intervention

Seven weeks after the initial symptoms, the patient underwent percutaneous angioplasty. Interventional procedures are illustrated in Fig. 3. Under general anesthesia, 7F, 5F, and 4F short vascular sheaths were inserted into the right femoral artery, left femoral artery, and left femoral vein, respectively. Systemic heparinization was performed during the intervention, the active clotting time being kept at about 250 to 300 seconds. For control angiography, a 4F diagnostic catheter was introduced into the left external carotid artery from the left femoral artery. A 7F Patlive, double-lumen, occlusive balloon catheter (0.057 in inner diameter, 90 cm long; Clinical Supply, Gifu) was introduced from the right femoral artery into the left ICA several centimeters distal from the carotid bifurcation. To prevent distal embolism during revascularization of the left ICA, retrograde blood flow was created. An artificial external arteriovenous shunt was established through the side port of the Patlive balloon catheter under proximal occlusion of the left ICA so that debris-containing blood could be drained through a filter device (P-J shunt circuit; Ube Junken, Tokyo) to the left femoral vein.

Before angioplasty, no retrograde blood flow from the C3 portion of the left ICA was observed when the proximal portion was occluded by balloon inflation. A Transit-II microcatheter (Cordis, Miami, Fla) and 0.016-in hydrophilic GT wire (Terumo, Tokyo) were slowly advanced distally through the occluded ICA. Perforation of the ICA was carefully avoided by observation of the movements of the tip of the guidewire using biplanar fluoroscopy and feeling of any resistance from the guidewire tip. Even though the proximal ICA was occluded by the balloon catheter,

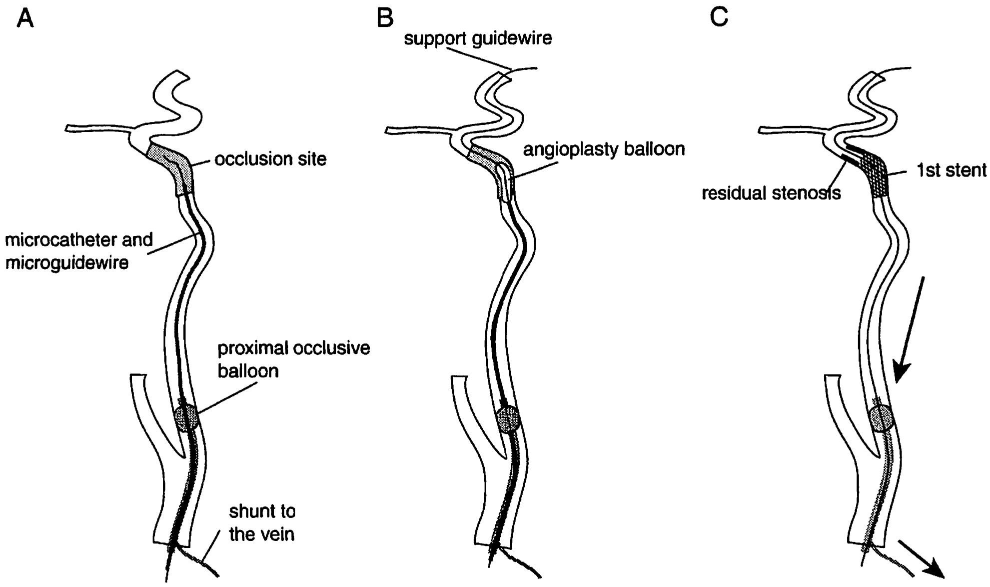

Fig. 3. Interventional procedures are illustrated. A: Under proximal balloon occlusion, microcatheter and microguidewire are traversed through the ICA occlusion. B: Balloon angioplasty is performed under proximal balloon occlusion. The tip of the support guidewire is in the middle cerebral artery. C: The first stent is deployed at the hard occlusion site. There is a residual stenosis at the cavernous portion. Arrows indicate the retrograde blood flow. Three stents are deployed. Antegrade carotid flow is restored.

injection of contrast media from the microcatheter was avoided so as to preclude possible distal embolism. The guidewire and microcatheter eventually traversed the lesion and entered the patient C3 portion of the ICA. The tip of the microcatheter was then brought to the M3 portion of the left middle cerebral artery (Fig. 4A). The microcatheter system was exchanged for a 0.014-in Choice PT floppy guidewire (300 cm; Boston Scientific, Miami, Fla) to enable stable navigation of the angioplasty balloon catheter and stent deployment. Over this support guidewire, a Gateway balloon catheter (2.5 × 12 mm; Boston Scientific, Fremont, Calif) was advanced to the C5 portion of the ICA because the region proximal to C5 seemed not to be completely occluded during the initial guidewire manipulation. Balloon angioplasty was repeated 4 times 30 seconds each under 8 atm (nominal pressure 6 atm) from the C5 to C3 of the left ICA (Fig. 4B and C). Although the control left external carotid angiogram did not yet demonstrate retrograde flow from the C3 portion to the proximal ICA, it showed a slow retrograde flow when the blood was aspirated through the side port of the Patlive balloon catheter, confirming recanalization of the left ICA (Fig. 5A). About 20 mL of the blood from C3 was slowly removed to the syringe attached to the Patlive catheter and forcefully drained to the

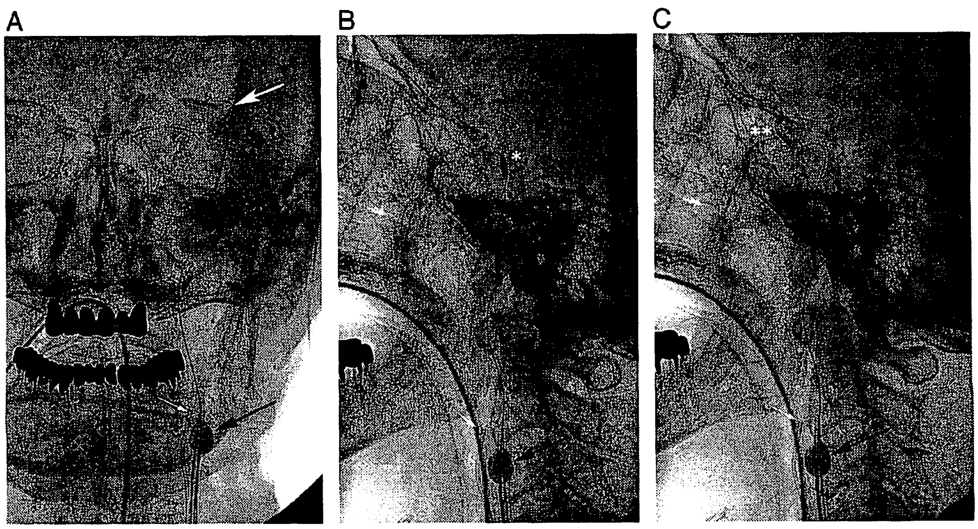

Fig. 4. A stiffer guidewire (large white arrow) is in the left distal middle cerebral artery (A: anteroposterior view). Balloon angioplasty (balloon size: 2.5 × 12 mm) was performed from C5 (single asterisk), where the hard occlusion was suspected (B: lateral view), to C3 (double asterisks) (C: lateral views). Black arrows indicate a Patlive balloon catheter occluding the carotid flow. Small white arrows indicate the 4F catheter tip used for a control external carotid angiogram.

left femoral vein through the filter device. The balloon of the Patlive catheter was then deflated, and recanalization of the left ICA and antegrade flow to the left cerebral hemisphere were confirmed in the control left ICA angiogram (Fig. 5B).

Judging from the left carotid angiogram, we thought that intracranial stenting was required because of the small caliber of the reopened left ICA. Because stenting of the entire occluded ICA segment was not realistic, we initially deployed, under proximal balloon protection, only 1 coronary stent (driver, 3.0 × 18 mm; Medtronic, Minneapolis, Minn) at the C5 portion, location of the likeliest initial ICA occlusion. However, because antegrade carotid flow was not sufficient, 2 additional coronary stents (driver, 3.0 × 20 and 4.0 × 30 mm) were deployed, under proximal balloon protection, proximal to the first one, from the C5 portion to the extracranial portion of the ICA (Fig. 6A). This stenting established ample left ICA antegrade flow (Fig. 6B). There remained the stenosis at the cavernous ICA, but it was impossible to navigate a fourth stent through the other three. The control angiogram disclosed no embolic occlusions of the middle cerebral or anterior cerebral arteries. There was no apparent debris trapped in the filter.

2.4. Postintervention course

The postintervention clinical course was uneventful. No new neurologic deficits were observed. Antiplatelet therapy was continued. Diffusion-weighted MR images on postintervention day 6 failed to show any new infarcts. Magnetic resonance angiography clearly demonstrated the left middle cerebral artery, which was not revealed preoperatively. The patient was discharged 12 days after the intervention. Mild blue toe syndrome (mild color changes of bilateral first and second toes) was noticed 1 month after intervention, which was conservatively managed without any sequels. However, because of the postintervention blue toe syndrome, the patient declined a follow-up catheter angiography. Computed tomography angiography 4 months after the intervention showed a good patency of the left ICA with a residual stenosis at the C3 portion (Fig. 7). Temporary blindness of the left eye, dizziness, and syncope had not recurred during the 6-month follow-up period.

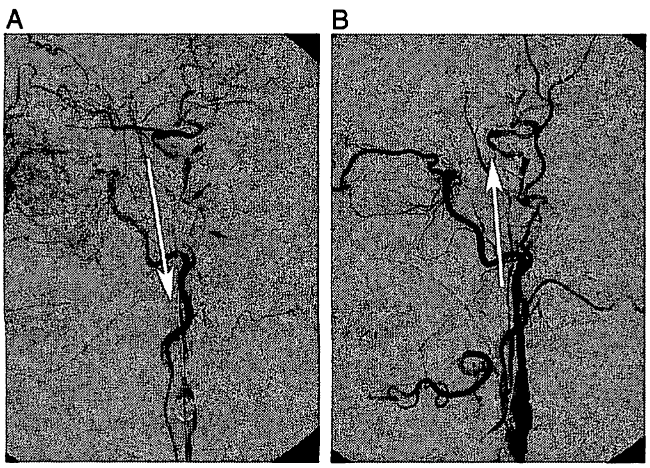

Fig. 5. Left external carotid injection (A: lateral view) after balloon angioplasty during aspiration of blood through the side port of the proximal occlusive balloon catheter, showing the retrograde flow (black arrows) from C3 to the proximal ICA. Left ICA injection (B: lateral view) after deflation of the proximal occlusive balloon, showing antegrade blood flow in the left ICA. White arrows indicate the direction of the blood flow in the ICA.

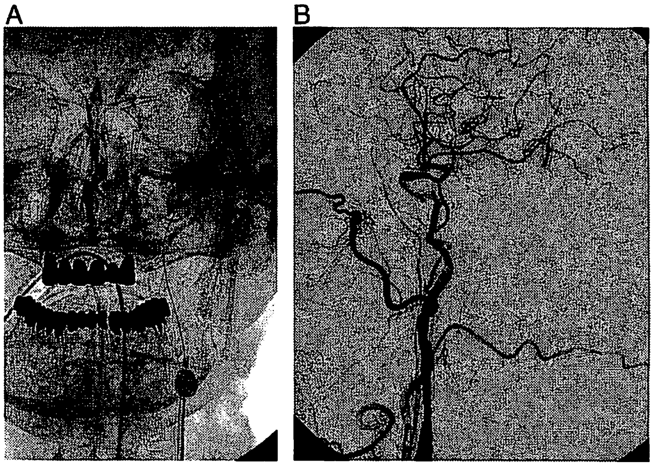

Fig. 6. Deployment of the second, 3.0 × 20 mm, coronary stent (A: anteroposterior view) under proximal flow control. Left common carotid injection (B: lateral view) after angioplasty, showing sufficient antegrade carotid flow.

3. Discussion

Internal carotid artery occlusion due to atherosclerosis may occur not only at the cervical bifurcation but also in the intracranial portion. Cerebral ischemia may result from an embolism or reduced regional cerebral perfusion. The clinical efficacy of fibrinolysis for acute embolic occlusion of the ICA has been well discussed [1,8]. However, treatment of atherosclerotic occlusion of the ICA was limited, and occlusion of the cervical ICA bifurcation has usually only been treated in the setting of an acute or subacute occlusion (usually within 2 weeks of ictus) with carotid endarterectomy, percutaneous angioplasty, or their combination [4,7,9,10,14,18,22,23]. Paty et al [14] reported on carotid endarterectomy for atherosclerotic ICA occlusion within 2 weeks of symptom onset in 87 patients. Internal carotid endarterectomy was successful in 30 patients, whereas the remaining 57 patients were treated with external carotid endarterectomy and ICA ligation due to extensive ICA plaque not amenable to ICA endarterectomy. Kasper et al [7] also reported emergency carotid endarterectomy for acute ICA thrombosis in 29 patients, in 24 of which antegrade ICA flow was established. When carotid endarterectomy is not feasible, EC-IC bypass is indicated in a selected group of patients with poor hemodynamic reserve [12]. Honda et al [5] treated a patient with a CTO of the intracranial vertebral artery by balloon angioplasty. This is the only case reporting reperfusion for a total occlusion of

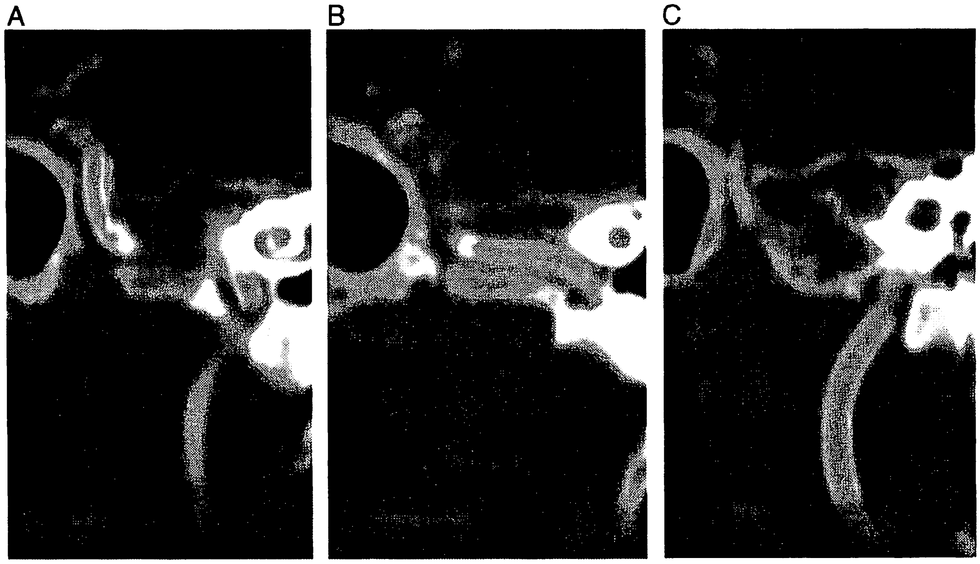

Fig. 7. Follow-up computed tomography angiography (reformatted images) performed 4 months after the intervention, showing good patency of the stents and left carotid blood flow. A: The distal first stent. B: The second stent. C: The proximal third stent.

the intracranial artery. Terada et al [21] recently reported the angioplasty of a CTO of the cervical carotid bifurcation, which is the only report of reperfusion for a CTO of the cervical ICA. To our knowledge, our case is the first revascularization of chronic stage, intracranial ICA.

Advances in carotid stenting technology now make it possible both to control proximal flow and to reverse flow during stenting [13]. We used this feature of proximal protection for the treatment of intracranial ICA occlusion. However, considering the small reversal flow that was present, we do not believe that artificial drainage to the venous system through the filter device was necessary. Simple aspiration of the blood would have been adequate for this procedure. Furthermore, we also found that the lower-profile flexible stent design has extended its use to cases of intracranial arterial stenoses [11,20].

It is known that revascularization of ICA stenoses may cause hyperperfusion syndrome, some of which are catastrophic [15]. The patients at risk for hyperperfusion syndrome are usually in severe hemodynamic compromise [17]. Cerebral blood flow in our patient was not severely impaired. Thus, we believed that hyperperfusion syndrome was less likely, and no such symptoms occurred.

Manipulation of the microcatheter/guidewire system should be performed carefully within the true lumen of the occluded intracranial ICA using biplanar fluoroscopy. *A double guidewire technique* is often used to penetrate lesions of the coronary CTO, which means that after the initial guidewire passes into the pseudolumen, it is left as a reference for the navigation of the second guidewire to the true lumen. When the tip of the guidewire enters the distal patent ICA (C3 in this case), careful observation of its movement and the control angiography can confirm the secure entrance of the guidewire in the distal ICA. Possible complications of such a revascularization are perforation, dissection, vessel rupture, arterial thrombosis, and distal embolism.

Chronic total occlusion of the coronary artery, iliac artery, and superficial femoral artery is routinely treated today by percutaneous angioplasty [2,3,6,19,21,24]. The procedural success (technical success without major adverse cardiac events) of angioplasty for coronary CTO is about 70% to 80%. Successful opening of a coronary CTO is associated with a significant improved 10-year survival compared with failed CTO (73.5% vs 65.1%) [19]. The technical success of angioplasty of a CTO of the iliac artery is more than 95%, and improvement of leg ischemia occurs in more than 90% of the patients [2,3].

Long occluded lesions (>50 mm) of the coronary artery have high restenosis rate (51%) even after successful recanalization [16], as is the case with CTOs of the iliofemoral artery [2]. Thus, careful follow-ups of patients are essential. Although clinical approaches to coronary, iliac, and femoral arterial occlusions and ICA occlusions are different, we believe that a CTO of the intracranial ICA can be successfully treated not only by EC-IC bypass but also with percutaneous angioplasty in selected patients.

In conclusion, percutaneous angioplasty of a CTO of the intracranial ICA is feasible when proximal flow control and evacuation of debris-containing blood are carefully performed during revascularization of the ICA. Although this is a single case report, it is shown that this intervention can be a successful alternative to EC-IC bypass surgery in a selected group of patients with symptomatic hemodynamic compromise, which is refractory to the best medical therapy.

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Commentary

Komiyama et al describe a case in which revascularization of the intracranial ICA was accomplished via percutaneous angioplasty. Revascularization for chronic vessel occlusion has been described in the coronary and peripheral literature, and such an application in the neurovasculature represents an exciting treatment alternative.

L. Nelson Hopkins III, MD
Department of Neurosurgery
University of Buffalo
Buffalo, NY 14209, USA