Routine completion angiography and intraoperative stent placement for the management of distal intimal flap during eversion carotid endarterectomy

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Although eversion carotid endarterectomy (CEA) has gained popularity, there are some concerns, including difficulties in handling the distal intimal flap, especially in those patients with a high lesion. Therefore, intraoperative angiography is routinely performed during CEA to check for intimal flaps and to assess the need for adjunctive maneuvers such as stent placement. We describe our adjunctive intraoperative carotid artery stenting after eversion CEA for unsatisfactory distal internal carotid artery end points detected by routine completion angiography. By conducting completion angiography when in doubt and adjunctive carotid artery stenting if indicated, the potential disadvantage of eversion CEA can be minimized. (J Vasc Surg Cases 2016;2:63-5.)

Carotid endarterectomy (CEA) is still considered the first-line treatment of patients with symptomatic or asymptomatic severe carotid artery stenosis. Although eversion CEA has gained popularity, there are some concerns, including difficulties in handling the distal intimal flap, especially in those patients with a high lesion. At the Jikei University School of Medicine, to overcome this issue and also to minimize intraoperative embolic complications, we have developed a small-incision eversion CEA technique, along with a unique vascular clamping sequence, which we refer to as the Jikei method. In addition, intraoperative angiography is routinely performed to check for intimal flaps and to assess the need for adjunctive maneuvers such as stent placement.

In this technical report, we describe adjunctive intraoperative carotid artery stenting (CAS) for unsatisfactory distal internal carotid artery (ICA) end points detected by routine completion angiography during eversion CEA using the Jikei method. The Institutional Review Board approved this study with a waiver of consent.

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TECHNIQUE

The Jikei method has been reported previously.[1] A 3-cm skin incision is made precisely over the lesion.

It is well known that embolization during CEA primarily occurs during the dissection phase and originates from the carotid plaque located within the ICA.[2] Therefore, we dissect the common carotid artery (CCA) and the external carotid artery and do not attempt to visualize the distal ICA before vascular clamping.

A 23-gauge butterfly needle is inserted into the CCA, and preoperative carotid and intracranial angiograms are obtained. After the CCA and external carotid artery are clamped, the ICA is separated from the CCA at its orifice, and then a certain amount of back bleeding from the ICA is encountered. However, it is easily controlled by holding the proximal end of the ICA with forceps. It is only at this point that the ICA is manipulated. Because there is no prograde flow that can carry embolus to the brain, intraoperative stroke potential can be minimized, although other technical defects, such as unsatisfactory distal end point, residual plaque, and thrombus formation due to platelet aggregation at the endarterectomy site, may also cause intraoperative stroke. Furthermore, the proximal end of the ICA can be moved in all directions during dissection, and this enables aggressive exposure of the distal ICA and makes it possible to handle high lesions. After dissection of the distal ICA circumferentially, a vascular clamp is applied to the distal ICA where the vessel wall is thought to be normal.

Eversion CEA is then performed, and the separated ICA is sutured back to the CCA with running 5-0 polypropylene. Completion angiography is performed to check for defects, including distal ICA intimal flap, residual stenosis, and intracranial embolization.

Table. Summary of the case series

	Case 1	*Case 2 (presented)*	*Case 3*
Age, years	73	70	85
Gender	Female	Male	Male
Location of the distal end of carotid plaque	Upper border of the second cervical vertebra	Upper border of the second cervical vertebra	Middle border of the second cervical vertebra
Choice of carotid stent	8- × 30-mm Precise stent (Cordis, Johnson & Johnson, Miami, Fla)	4- × 15-mm Express stent (Boston Scientific, Natick, Mass)	6- × 20-mm Precise stent
Postoperative cerebral infarction	No	No	No
Outcome	Satisfactory	Satisfactory	Satisfactory

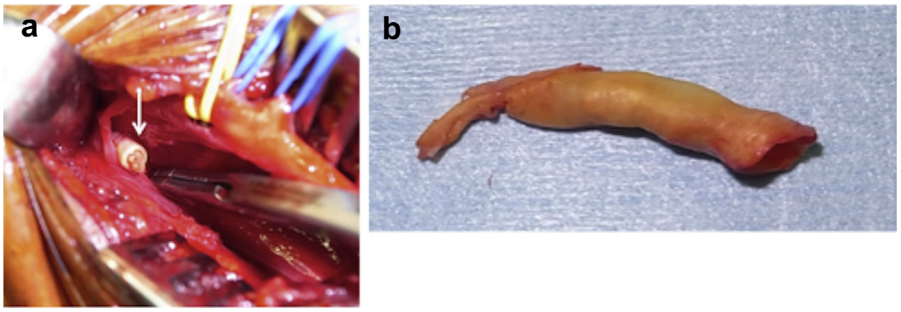

Fig 1. a, Intraoperative photograph of the distal internal carotid artery (ICA). Although the plaque was excised up to the surgical limit, residual plaque remained at the distal ICA (*arrow*). **b,** ICA plaque. The resected plaque measured approximately 4.5 cm in length. However, a thick flap was present at the cranial end of the plaque that was responsible for the intimal flap.

Adjunctive CAS for unsatisfactory distal ICA end points was performed in 3 of 136 (2.2%) consecutive eversion CEAs using the Jikei method between 2007 and July 2014 at the Jikei University Hospital. A list of these three cases is shown in the Table. Cases were excluded in which we opted for conventional CEA because of the lesion being predominantly located in the CCA. Of these 136 CEAs, no operative deaths were encountered, but postoperative cerebral infarction was observed in two cases (1.4%). We present one of those three cases.

CASE REPORT

A 70-year-old man underwent CEA because of a high-grade preocclusive carotid stenosis extending from the inferior border of the third cervical vertebra to the upper border of the second cervical vertebra. Because the distal end of the plaque extended beyond the surgical limit, we confined the resection up to the limit, and the distal end of the plaque was excised with scissors in a circular fashion (Fig 1). Completion angiography revealed the presence of an intimal flap at the distal ICA. Because further surgical correction was impossible without a mandibular subluxation, a 5F sheath was inserted through the skin 2 cm caudal to the incision and placed into the CCA. Under fluoroscopic guidance, a 0.018-inch Thruway wire (Boston Scientific, Natick, Mass) was advanced across the flap, and a 4- × 15-mm Express stent (Boston Scientific) was deployed to tack the intimal flap (Fig 2). Final angiography showed satisfactory outcome.

DISCUSSION

The most serious complication associated with CEA is stroke, and great attention should be paid to avoid this event. We believe that the Jikei method has several advantages compared with conventional CEA or standard eversion technique for several reasons.[1] However, management of the distal ICA end points is of concern because tacking of the distal flap may be cumbersome, especially in patients with a high lesion. In most cases, the carotid plaque is confined to the carotid bulb and the distal end tapers naturally. Thus, the plaque can be completely resected in a circular manner, and we can achieve a smooth distal ICA lumen without the need for tacking sutures. In fact, we obtained satisfactory outcomes in 133 of 136 (98%) CEAs using this procedure. However, when a satisfactory result is not achieved, the surgeon should be prepared to perform adjunctive CAS intraoperatively to treat intimal flaps that are difficult to repair surgically.

Defects that are not distal or that are located where surgical revision should be performed without difficulty are treated surgically. However, most cases with an unsatisfactory distal end point are high lesions. In these circumstances, the endarterectomy has already been accomplished as distally as possible to the level of surgical limit and mandibular subluxation carries certain morbidity, so we believe that adjunctive CAS that can be performed readily is a reasonable alternative. In addition, adjunctive CAS is safe with regard to cerebral embolization because the source of embolization, namely, the carotid plaque, has already been removed during

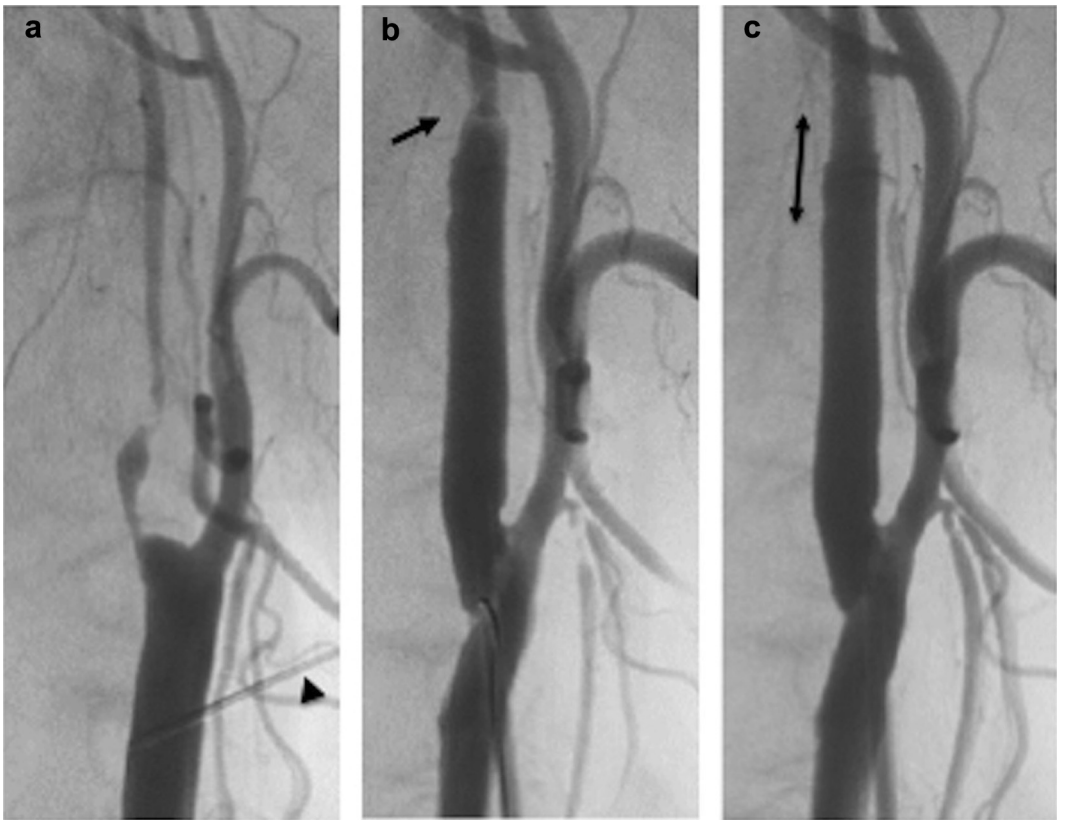

Fig 2. **a,** Preoperative angiogram shows preocclusive and diffuse internal carotid artery (ICA) lesion. String sign is also present. *Arrowhead*, Butterfly needle. **b,** Completion angiogram reveals an intimal flap (*arrow*) at the distal ICA despite excision of the plaque up to the surgical limit. **c,** Angiogram after stenting. A carotid stent (Express SD) was deployed across the flap, and the final angiogram shows satisfactory outcome. Note the resolution of the string sign. *Arrow*, Stent.

CEA. We do not use a distal protection device during adjunctive CAS for this reason and also because protection devices can cause distal ICA dissection or spasm.

As seen in the presented case, if significant distal flaps are noted, adjunctive CAS is performed because we believe that such dissection can possibly extend to thrombosis of the ICA or thrombus formation that can lead to embolization. Adjunctive CAS after CEA was reportedly performed in 2.9% to 4.1% of CEAs,[3,4] which is similar to our percentage.

With regard to the choice of carotid stent, we basically opt for self-expandable stents for the distal intimal flap. However, when the defect is located in even narrower distal ICA, we have no other alternative but to use a balloon-expandable stent because 4-mm self-expandable stents are not available at present.

We believe that intraoperative angiography is beneficial for optimal performance of eversion CEA, especially if there is concern about the distal end point. It allows thorough evaluation of the distal ICA sites. Therefore, the dilemmas concerning the distal intimal flap that may occur during eversion CEA can be minimized. Although completion duplex ultrasonography also allows the surgeon to assess carotid lesions, it is obviously difficult to visualize lesions located cephalad to the mandible in addition to intracranial circulation. Regarding the method for pre-CEA and post-CEA angiography, we puncture the CCA directly, rather than performing transfemoral angiography, because catheter manipulation in the aortic arch carries the risk of embolization.

CONCLUSIONS

By conducting completion angiography if in doubt and adjunctive CAS if indicated, the potential disadvantage of eversion CEA can be minimized.

REFERENCES

1. Ohki T. Enhancing carotid endarterectomy. Endovascular Today October 2012:68-77.
2. Ackerstaff RG, Moons KG, van de Vlasakker CJ, Moll FL, Vermeulen FE, Algra A, et al. Association of intraoperative transcranial Doppler monitoring variables with stroke from carotid endarterectomy. Stroke 2000;31:1817-23.
3. Ross CB, Ranval TJ. Intraoperative use of stents for the management of unacceptable distal internal carotid artery end points during carotid endarterectomy: short-term and midterm results. J Vasc Surg 2000;32:420-8.
4. Tameo MN, Dougherty MJ, Calligaro KD. Carotid endarterectomy with adjunctive cephalad carotid stenting: complementary, not competitive, techniques. J Vasc Surg 2008;48:351-4.

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