Case Report

Surgical Treatment of Atherosclerotic and Dysplastic Aneurysms of the Extracranial Internal Carotid Artery

Tadanori Kawada, MD, Atsuyoshi Oki, MD, Katsuyoshi Iyano, MD, Atsushi Bitou, MD
Yoshiharu Okada, MD, Yoshiaki Matsuo, MD, Masahiro Aiba, MD, Makoto Yamada, MD,
Tetsuro Michihata, MD, Koichi Inoue, MD, and Toshihiro Takaba, MD

Atherosclerotic and dysplastic aneurysms of the extracranial internal carotid artery are rare in Japan. We have experienced only four cases since 1982. The patients were two men and two women with a mean age of 67 years (range 51 to 82 years). All four patients had a saccular type aneurysm; sizes ranged from 30 to 75 mm. Aneurysmectomy and end-to-end anastomosis of the internal carotid artery could be performed in two patients. One patient underwent aneurysmorrhaphy followed by primary closure of the internal carotid artery, and the remaining patient underwent aneurysmectomy followed by a prosthetic graft replacement (6 mm-PTFE graft). During aneurysm repair, simple arterial cross-clamping (time 18 to 57 min; mean±SD: 31.3±18.0 min) was used in all patients. During arterial clamping of the carotid artery in two patients, somatosensory evoked potentials and regional cerebral oxygen saturation detected by near-infrared spectroscopy remained within normal ranges. All patients survived without neurologic deficits. These findings indicate that intraluminal shunting may be unnecessary during aneurysm repair if the patient does not have obstructive disease in the contralateral carotid artery and if no somatosensory evoked potentials or regional cerebral oxygen saturation abnormalities occur during proximal arterial clamping. After aneurysmectomy, end-to-end anastomosis of the internal carotid artery is the preferred method of repair if the length of the distal internal carotid artery permits. (Ann Thorac Cardiovasc Surg 2002; 8: 183–7)

Key words: carotid artery aneurysm, atherosclerosis, fibromuscular dysplasia

Introduction

Aneurysm of the extracranial internal carotid artery (ICA) is not as common in Japan as is generally assumed. In Western countries, the carotid artery aneurysm is also rare, and more than one-third of such aneurysms are secondary pseudoaneurysms that arise after endarterectomy for carotid artery stenosis.[1)] In Japan, endarterectomy is not often performed; hence, surgical experience with the carotid artery aneurysm is further limited. And almost all carotid artery aneurysms appear to be caused by true atherosclerosis or fibromuscular dysplasia. We describe our surgical techniques and monitoring means recently used for detecting cerebral ischemia during surgery, although only four patients with an ICA aneurysm requiring surgical repair have been encountered since 1982.

From the First Department of Surgery, Showa University School of Medicine, Tokyo, Japan

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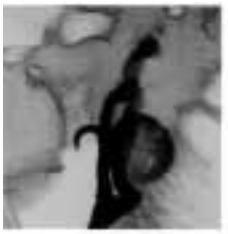
Address reprint requests to Tadanori Kawada, MD: First Department of Surgery, Showa University School of Medicine, 1-5-8 Hatanodai, Shinagawa-ku, Tokyo 142-8666, Japan.

Patients and Methods

Between May 1982 and June 2001, four patients (two men and two women) underwent surgical repair of an extracranial ICA aneurysm. Patient age ranged from 51 to 82 years with a mean±SD of 67.0±14.9 years. All four patients noticed a pulsatile mass at the anterolateral neck. None of these patients had a cerebrovascular accident, but three had nonspecific symptoms like dizziness, neck pain, and hoarseness. The aneurysms were located at the

Table 1. Preoperative clinical features

Patient	1. K. O.	2. Y. I.	3. E. I.	4. T. K.
Age	51	77	58	82
Sex	Male	Female	Male	Female
Symptom	(–)	Dizziness, local heat	Neck pain	Hoarseness
Aneurysm				
Location	Left	Left	Right	Left
Size	30 mm	75 mm	45 mm	30 mm
Type	Saccular	Saccular	Saccular	Saccular
DSA				
Contralateral carotid lesion	None	None	None	None

DSA: digital subtraction angiography

proximal segment of the ICA just distal to the bifurcation: three on the left side and one on the right. The aneurysms ranged in maximum diameter, as estimated on contrast-enhanced computed tomography images, from 30 to 75 mm (Table 1).

Angiography revealed a saccular-type aneurysm originating from the proximal segment of the ICA in all cases. In no case was an obstructive or aneurysmal lesion of the contralateral carotid artery detected by brachiocephalic four-vessel arteriography.

Operative technique

All four patients were treated under general anesthesia, and short latency somatosensory evoked potentials (SSEPs) and regional brain tissue oxygen saturation (rSO_2) determined by near-infrared spectroscopy (TOS-96, Tostec Co., Tokyo) were monitored as indicators of neurophysiological status in two patients. The carotid artery was dissected with a vertical incision anterior to the sternocleidomastoid muscle. After the anterior facial vein was ligated and divided, the internal jugular vein was posteriorly retracted, and the common carotid artery was encircled with a tape. The aneurysm was dissected carefully to avoid hypoglossal nerve injury. The ICA distal to the aneurysm was identified and encircled with a tape in Cases 1 and 4, but the ICA could not be identified in Cases 2 and 3. In all cases, simple proximal arterial clamping immediately after systemic administration of heparin at 100 IU/kg body weight was used during aneurysm repair.

Aneurysmorrhaphy followed by primary closure of the ICA with 4-0 polypropylene interrupted sutures was performed in Case 1. End-to-end anastomosis of the ICA was performed after aneurysmectomy in Case 4 because the distal carotid artery was significantly elongated and was of sufficient length. In Cases 2 and 3, the ICA distal to the aneurysm could not be identified because the aneurysm was too large. Therefore, the aneurysm was opened after cross-clamping of the common and external carotid arteries, and bleeding from the distal carotid artery was controlled by a 5F Fogarty balloon catheter introduced from inside the aneurysm. Aneurysmectomy was performed in both cases and the ICA was end-to-end anastomosed in Case 2 (Fig.1) and reconstructed with a 6-mm PTFE graft in Case 3 without the use of an intraluminal shunt (Fig. 2).

Results

All patients survived without neurological deficits despite the fact that no intraluminal shunt was used during arterial cross-clamping period which ranged from 18 to 57 minutes (Table 2). SSEP and rSO_2 were monitored continuously during surgery in two patients, and neither significant change in SSEP amplitude nor reduction of brain tissue rSO_2 was observed during proximal arterial clamping. In the other two patients, there was no neurophysiologic monitoring because these monitoring devices were not available. Only minimal complications related to the surgical treatment occurred after surgery and no patient

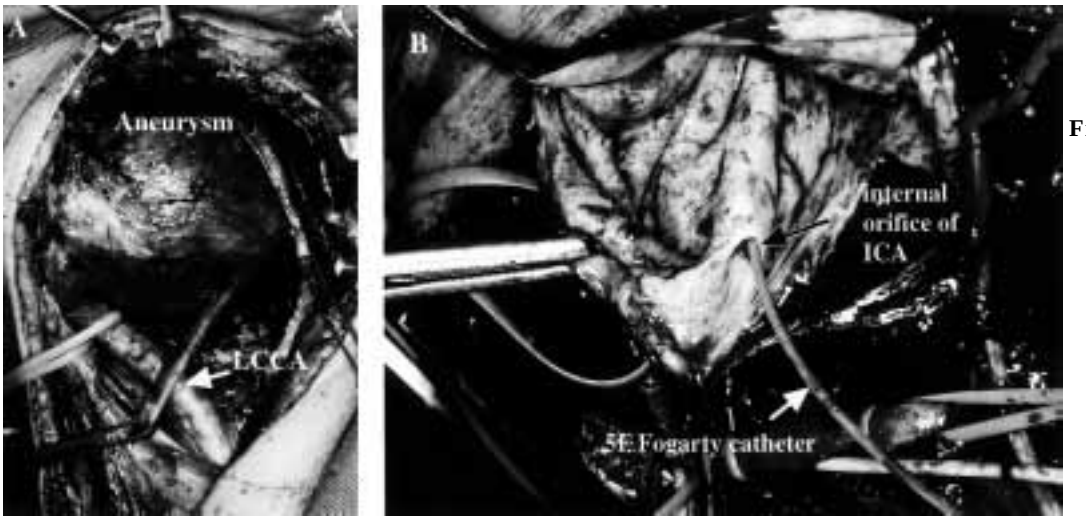


Fig. 1. Intraoperative views in Case 2. A: Left common carotid artery is encircled with a tape. Distal ICA is not seen. B: Aneurysm opened after proximal clamping. Bleeding from the distal ICA is controlled by a balloon catheter introduced from inside the aneurysm.

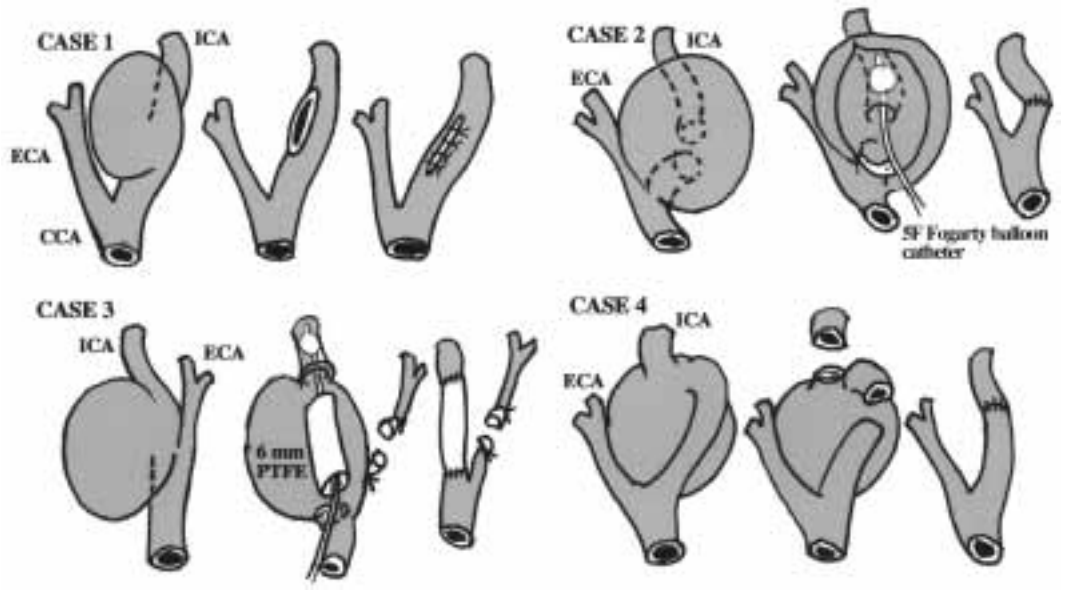


Fig. 2. Diagram of the operative technique in each of the 4 cases.

showed cranial nerve or central nervous system injury. In Case 1, postoperative arteriography performed one month after surgery showed significant stenosis of the ICA, but brain CT scans showed no neurologic defects or other abnormalities. The patient has been regularly observed for more than 15 years, and he is doing well without physical exercise restrictions. In Case 4, hoarseness due to preoperative recurrent nerve palsy caused by pressure of the aneurysm on the nerve and numbness of the left ear lobe due to injury of a minor sensory nerve remained after surgery.

Pathological study revealed fibromuscular dysplasia associated with thinning of the arterial wall, which was partially replaced with collagen fibers and irregularly arranged and proliferated smooth muscle cell bundles in Cases 1 and 4 (Fig. 3) and severe atherosclerosis with intimal fibrosis and subintimal calcification in Cases 2 and 3. Mural thrombus was found only in Case 3.

Discussion

The extracranial carotid artery aneurysm is rare; surgical intervention is estimated at 0.5% to 1.8% of all carotid artery procedures in both the United States and Europe.[1-4] The Japanese literature has also been only small case reports of the surgically-treated carotid artery aneurysms so far.[5,6] The 4 aneurysms described herein were all saccular and, curiously, appeared morphologically similar;

Table 2. Intraoperative findings and postoperative results

Patient	1. K. O.	2. Y. I.	3. E. I.	4. T. K.
Op. technique	Aneurysmectomy primary closure	Aneurysmectomy end-to-end anastomosis	Aneurysmectomy graft replacement	Aneurysmectomy end-to-end anastomosis
Stump pressure	ND	55 mmHg	ND	70 mmHg
Shunt	(–)	(–)	(–)	(–)
AXCL time	20 min	30 min	57 min	18 min
Monitoring				
SSEP	No change	ND	ND	No change
rSO_2	ND	ND	ND	No change
Complication	No	No	No	Numbness of ear lobe
Outcome	Survived (ICA stenosis)	Survived	Survived	Survived
Histology	FMD	Atherosclerosis	Atherosclerosis	FMD

ND: not determined, AXCL: arterial cross-clamp time, FMD: fibromuscular dysplasia

Fig. 3. Pathological study in Case 4 showing disrupted internal elastic bands and medial layer partially replaced with collagen fibers and irregularly arranged and proliferated smooth muscle cell bundles, suggesting fibromuscular dysplasia as the cause of the aneurysm.

nevertheless, histological analysis showed atherosclerosis in two patients and dysplasia in two. The incidence of fibromuscular dysplasia was greatest in some reported series,[3] whereas atherosclerosis was predominant in other series.[1,4,7] Faggioli et al. proposed that atherosclerotic changes may be a secondary process in the dysplastic artery.[3]

Surgical indications for the ICA aneurysm have not yet been established, because little information is available regarding the natural history of atherosclerotic and dysplastic ICA aneurysms. Some surgeons propose surgical repair as the treatment of choice because of the potential risks of stroke from either thrombosis or distal embolization[8] and rupture, especially in patients with a large aneurysm involving the oropharynx and cranial nerve.[7] In our two patients whose aneurysm was more than 30 mm in diameter, the ICA distal to the aneurysm was very difficult to identify and dissect; thus, the risk of cranial nerve injury was high. Therefore, we believe that surgeons should operate before the aneurysm reaches a diameter greater than 30 mm. In the first successful surgical treatment of a carotid artery aneurysm, performed by Sir Astley Cooper in London in 1808, the common carotid artery was ligated proximally to an ICA aneurysm.[9] Nowadays, vascular reconstruction after aneurysmectomy is a well-accepted surgical procedure because of the high risk of morbidity and mortality after carotid artery ligation. Nevertheless, surgical treatment of the carotid artery aneurysm presents some problems. Sometimes, it is difficult to approach the aneurysm, especially a large aneurysm extending to the skull base. There is always the potential for stroke or cranial nerve injury with surgical repair of the aneurysm. Fortunately, most extracranial carotid aneurysms, especially those caused by atherosclerosis and dysplasia, are confined to the level of the bifurcation and the proximal segment of the ICA.[10] When the aneurysm is quite large, as in our Cases 2 and 3, a balloon catheter can be introduced from the internal orifice of the distal carotid artery after the aneurysm is opened, and the thrombus is removed under proximal clamping; this procedure obviates the need for a more distal dissection of the aneurysm and helps control bleeding.[1,7] The risk of intracranial nerve injury may be reduced as well.

In most saccular aneurysms, direct end-to-end anastomosis of the ICA is feasible because the distal carotid artery is sufficiently elongated. When end-to-end anastomosis can not be performed, the autogenous vein graft is advocated as the graft of choice.[7,11] But Faggioli et al. warned against the use of the vein graft because of the high incidence of postoperative dilatation or stenosis associated with its use.[3] Dacron and PTFE grafts have been also used; however, they are associated with a potential risk of late stenosis due to intimal hyperplasia.[1] Some authors prefer the use of aneurysmorrhaphy followed by prosthetic patch angioplasty in cases of saccular or fusiform aneurysm.[1,7] In any case, reconstruction of the carotid artery by any means possible is justified, but regular long-term follow-up observation by Doppler-ultrasonography, CT scanning, or MRI angiography is necessary.

Controversies exist as to whether an intraluminal shunt should be used during aneurysm repair. Some surgeons use it routinely because of the prolonged clamp-occlusion time required for complicated repair of these aneurysms.[10] But, Gohra et al. propose, however, that an intraluminal shunt is unnecessary if syncope or EEG changes do not occur during a 10-minute preoperative carotid artery occlusion test with a balloon catheter.[12] Although stump pressure is not sensitive enough to accurately predict the need for a shunt use, Moreau et al. advocate that routine use of the intraluminal shunt is unnecessary if the stump pressure can be maintained at more than 50 mmHg by increasing systemic blood pressure artificially up to a maximum of 200 mmHg. The shunt procedure may be technically difficult in some cases and it is associated with distal embolization. Zwolak et al. reported that it might not be coincidental that a shunt had been used in all their patients who experienced stroke as a postoperative complication.[11] No neurological complication developed in our four patients despite the use of simple clamping during carotid aneurysm repair. SSEP wave amplitude and rSO_2 did not change at all during proximal clamping in the two patients for whom these were monitored. Simultaneous reduction of rSO_2 below 55% and significant changes in SSEP amplitude are strongly suggestive of depletion of the oxygen supply to the brain. However, it may be practical to pay more attention to rSO_2 reduction to quickly decide to use an intraluminal shunt or not, because rSO_2 responds more rapidly to ischemia than SSEP.

In conclusion, end-to-end anastomosis is feasible in cases in which the ICA is of sufficient length. When a large aneurysm extends to the skull base, balloon occlusion from inside can obviate the need for extensive dissection of the aneurysm and prevent subsequent intracranial nerve injury. The intraluminal shunt may be unnecessary if no contralateral occlusive lesion is detected by four-vessel arteriography and no significant, simultaneous changes in SSEPs and rSO_2 develop during proximal arterial clamping.

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