Aneurysms of the Cervical Internal Carotid Artery: Experience in Surgical and Intravascular Management

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Summary: Aneurysms of the cervical internal carotid artery (ICA) are known to present with a mass, fatal hemorrhage or cerebral ischemic attack. The recent advances in skull base surgery and intravascular procedures have provided a wide variety of therapeutic options and are expected to improve results.

We report our experience in 5 patients; 2 patients presented with focal neurological deficit due to embolism, 2 with a growing cervical mass, and 1 was symptom-free. Arterial reconstruction was performed after aneurysmal resection in 2 patients. In 1 patient whose aneurysm was located high at the C2 level, vertical mandibular osteotomy was useful for resecting the aneurysm and primary end-to-end anastomosis. In the other patient who had dilated distal carotid artery and multiple vertebral and basilar aneurysms, an extracranial-intracranial saphenous vein bypass was placed to prevent potential increase of the hemodynamic stress in the posterior circulation. The most recent case with a dissecting aneurysm was treated using a stent with preservation of the ICA flow. For the other 2 patients, trapping and encasement of aneurysms were performed. In our 5 patients, three aneurysms were proved atherosclerotic and 2 were spontaneously dissecting in nature. There was neither mortality nor additional morbidity except for transient lower cranial nerve palsy in 1 case.

We found that minimally invasive diagnostic modalities such as magnetic resonance angiography, Doppler ultrasonography and 3-D-CT angiography were useful in evaluating the change of aneurysmal size. The hemodynamic effect of the intended treatment on the coexisting vascular lesions should be considered before treatment. Technique in skull base surgery is essential in the treatment of distally located aneurysms. Recent advances in intravascular procedures offer less invasive alternatives and include balloon, coiling and stent placement.

Key words:

- aneurysm
- cervical carotid artery
- surgery

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Introduction

Aneurysms of the cervical internal carotid artery (ICA) are known to present with a mass, fatal hemorrhage or cerebral ischemic attack. They are, however, rare cases accounting for about 1% of surgically indicated vascular lesions of the neck.²⁾⁴⁾⁶⁾⁷⁾¹⁰⁾⁻¹⁵⁾¹⁸⁾²⁰⁾ The recent advances in the skull base surgery¹⁾⁵⁾¹⁶⁾¹⁹⁾ and intravascular procedures³⁾⁹⁾ have provided a wide variety of therapeutic options and are anticipated to improve the results.

In this paper, we report our experience of direct surgery in 4 patients and of intravascular management in another patient, and we discuss the therapeutic strategy.

Patients and Results

The 5 patients, three men and two women, ranged in age from 46 to 57 years (Table 1). Two patients had focal neurological deficit due to embolism, two presented with a growing cervical mass, and one was symptom-free. One (Patient 2) of the 4 patients undergoing balloon occlusion

Table 1 Characteristics of patients with aneurysms at the cervical internal carotid artery

Partient	Age & Sex	Initial symptom	Side Level Size : ID OD	Treatment	Outcome (period of follow-up)	Balloon occlusion test result	Etiology of aneurysm	Remark
1	55M	TIA	right C2 2 cm 2 cm	Aneurysmectomy Primary anastomosis	Excellent (5 yrs)	(-)	Atherosclerosis	
2	46M	TIA	right C3 1.5 cm 1.5 cm	Stent placement	Excellent (3 mo)	(+)	Dissecting (*)	ICA stenosis (90%) between C1-C3
3	47M	growing cervical mass	right C2-C3 2 cm 5 cm	Aneurysmectomy	Good (lower cranial nerve palsy) (5 yrs)	(-)	Dissecting	Neurofibromatosis type 1
4	51F	growing cervical mass	right C2-C3 5 cm 5 cm	Aneurysmectomy EC-IC saphenous vein bypass	Excellent (transient lower cranial nerve palsy) (2 yrs)	(-)	Atherosclerosis	BA & VA aneurysms ICA dilatation between C1-C2
5	57F	free	left C3 2 cm 2 cm	Encasement	Excellent (4 yrs)	not performed	Atherosclerosis (*)	

ID, OD, TIA, C and asterisks represent inner diameter, outer diameter, transient ischemic attack, cervical vertebral body and histologically not verified, respectively.

test of the ICA was unable to tolerate the test. Four patients were treated by direct surgery and one by intravascular procedures. There was neither mortality nor morbidity except preexisting and irreversible lower cranial nerve palsy in Patient 3 and transient palsy in Patient 1.

Patient 1

A 55-year-old man developed transient ischemic attack (TIA) of weakness of the left side. Angiography demonstrated an aneurysm in the right ICA at the level of second cervical vertebral body (C2). TIA recurred in spite of medication.

Three-dimensional computed tomographic (3-D-CT) angiography depicted a surgical topography simulating vertical mandibular osteotomy, which was supposed to be adequate for the expected surgery (**Fig. 1, left**). The osteotomy was performed posteriorly to the exit of the inferior alveolar nerve from the mandibular bone, which provided a good operative view and enough room for aneurysmectomy and primary end-to-end anastomosis

(**Fig. 1, right**).

Patient 2

A 46-year-old man developed amaurosis fugax of the right eye followed by transient weakness of the left side. Angiography demonstrated a small aneurysm of the right ICA and irregular narrowing of the ICA at the C2-C3 levels (**Fig. 2, left**). The nature of the aneurysm was considered to be dissecting, and the occlusion test of the artery was positive. Medication apparently prevented further ischemic attack with recovery of the caliber of the ICA to 2.0 mm during 2-month observation. Since the aneurysm enlarged gradually to 15 × 6 mm in size (**Fig. 2, center**), we adopted intravascular procedures to eliminate the aneurysm from the circulation 10 weeks after the ictus. The ICA was dilated using a 4.0-mm balloon catheter. A Palmaz wall stent of 4 mm in diameter (Johnson & Johnson Interventional Systems Company, Warren, NJ) was then placed to cover the neck of the aneurysm and to reconstruct the arterial lumen. The ICA diameter increased to

Fig. 1 A three-dimensional-computed tomographic (3-D-CT) angiography in Patient 1 simulated the topography after the mandibular angle resection (*left*). An aneurysm was visualized at the level of second cervical vertebral body. Postoperative angiography disclosed good patency of the ICA (*right*).

Fig. 2 Right carotid angiograms in Patient 2. *Left*: Two weeks after the ictus, a small aneurysm and irregular narrowing of the internal carotid artery (ICA) were demonstrated. *Center*: Two months later, the aneurysm enlarged with recovering the ICA caliber. *Right*: Three months after a stent placement, the ICA flow was confirmed to be preserved without visualizing the aneurysm.

5mm with no neurological deficits (**Fig. 2, right**).

Patient 3

A 47-year-old man underwent surgery for the the cervical mass by an ENT and its removal was given up due to massive hemorrhage two months before. Magnetic res-

onance (MR) images and angiography demonstrated an partially thrombosed aneurysm of the ICA. It was resected via conventional approach with no arterial reconstruction to prevent additional injury to the impaired lower cranial nerves.

Fig. 3 Magnetic resonance (MR) angiography in Patient 4 showed a large aneurysm in the right ICA with the dilating distal segment up to the skull base. A fusiform aneurysm in the basilar artery was also visualized (left). The saphenous vein bypass supplied the whole area of the right hemisphere (right).

Patient 4

A 51-year-old woman presented with an enlarging mass on the right side of the neck. Angiography disclosed an aneurysm 5cm in diameter in the right ICA at the C2-C3 levels and irregular dilatation of the ICA extending up to the skull base (Fig. 3, left). A basilar trunk aneurysm 2.0cm in diameter and vertebral artery aneurysms were found incidentally. Although the balloon occlusion test yielded negative result, an extracranial- intracranial (EC - IC) saphenous vein bypass was placed after trapping of the ICA so as not to increase hemodynamic stress in the posterior circulation. Postoperative angiography revealed that the saphenous vein bypass supplied the whole area of the right hemisphere (Fig. 3, right) with little apparent change of the posterior circulation.

Patient 5

In a 57-year-old woman, an aneurysm was incidentally found in the left ICA. Although it changed little in size during three-year observation, she was very anxious about the possible enlargement. To prevent the enlargement, the aneurysm was encased together with internal and external carotid arteries using a vascular prosthesis (Dacron vascular prosthesis, 22 mm).

Discussion

Numerous etiological factors have been reported for

cervical ICA aneurysms. Excluding aneurysms developing after carotid endarterectomy (CEA) or trauma, atherosclerosis and spontaneous dissection are the most frequent causes of the aneurysms, at prevalence of approximately 45% and 44%, respectively.²⁾⁴⁾⁶⁾⁸⁾¹⁰⁾⁻¹⁵⁾¹⁸⁾²⁰⁾ In our 5 patients, 3 aneurysms were atherosclerotic and 2 were spontaneously dissecting.

Aneurysms should be treated when they enlarge or when repeat ischemic attack occurs despite medication.⁷⁾ Careful observation is essential for patients with dissecting lesions that develop spontaneously or after trauma, since two-thirds of these resolve spontaneously.⁶⁾¹⁷⁾ Although surgery is generally not indicated for asymptomatic aneurysms, the patients who express dreadful anxiety about the pulsating cervical mass could be candidates for therapeutic intervention.

It is essential in the treatment for ICA aneurysm to devise a strategy and choose an appropriate approach depending on the size, location, nature, collateral circulation, associated vascular lesions and age of the patient. In addition to the techniques for the carotid endarterectomy, various surgical tactics have been proposed for accessing lesions at the skull base.¹⁾⁵⁾¹⁶⁾¹⁹⁾ These can provide enough room for controlling the distal side of the aneurysm or primary anastomosis of the artery when the aneurysm is distally locating. Except for aneurysms of infectious origin, preservation of the ICA flow is generally advisable. Moreau

*et al.*⁷⁾ reconstructed the artery in 37 of their 38 patients using primary anastomosis (n=11), interposed saphenous vein grafting (n=12) or aneurysmorrhaphy (n=14). In their 26 patients treated surgically, Piepgras *et al.*¹⁰⁾ performed primary anastomosis (n=6), interposed grafting (n=7) or saphenous vein bypass grafting (n=4).

It is probably important in patients with associated vascular lesions to consider the potential hemodynamic effects induced by the treatment for the aneurysm. Recent advances in intravascular procedures offer less invasive alternatives and include balloon, coiling and stent placement.^{3,9)} We obtained a good result in Patient 2 by the placement of a stent without coiling, but long-term follow up is essential.

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