Giant Internal Carotid Aneurysm at the Cavernous Portion with Abrupt Disappearance of N20 100 Minutes after Carotid Occlusion
—Case Report—

Tatsuya ISHIKAWA, Hiroyasu KAMIYAMA, Mitsuhiro TADA, Tatsuo IHARA and Hiroshi ABE

Department of Neurosurgery, Hokkaido University School of Medicine, Sapporo

Abstract

A 69-year-old female with bilateral giant internal carotid aneurysms at the cavernous portion was admitted with complaints of diplopia and radiating pain. The aneurysm on the left side was larger and symptomatic, and treated with the internal carotid artery ligation and the superficial temporal artery-middle cerebral artery (STA-MCA) double bypasses. However, intraoperative somatosensory evoked potential (SEP) monitoring revealed the disappearance of N20 100 minutes after the carotid occlusion and rapid recovery of N20 following flow restoration. Therefore, a high-flow bypass using radial artery grafting was installed, and carotid ligation was performed again without any change in SEP. Postoperative angiograms demonstrated complete disappearance of the aneurysm and sufficient blood supply through a patent high-flow bypass. Although both STA-MCA double bypasses were occluded, no change in cerebral blood flow was detected by single photon emission computed tomography. Her neurological deficits improved, and she is being followed as an outpatient with a plan of second surgery for the remaining aneurysm.

Key words: giant aneurysm, carotid ligation, extracranial-intracranial bypass, somatosensory evoked potential, radial artery graft

Introduction

Inaccessible internal carotid aneurysms are usually treated by carotid ligation combined with an extracranial-intracranial (EC-IC) arterial bypass. However, it is difficult to determine whether the carotid artery can be ligated safely. Recently, several reports have described the usefulness of the occlusion test using a balloon catheter for this purpose. However, the length of occlusion time and complications of the balloon occlusion test were not fully discussed.

We encountered a case of bilateral giant internal carotid aneurysms at the cavernous portion, one of which was successfully treated by ligation of the internal carotid artery and EC-IC bypass surgery. In this case, somatosensory evoked potential (SEP) monitoring detected the disappearance of N20 100 minutes after the test carotid occlusion and rapid recovery of N20 after flow restoration. We report this case in detail and discuss the treatment for such aneurysms.

Case Report

A 69-year-old housewife was admitted with complaints of diplopia and radiating pain in the left forehead and cheek. Neurological examination revealed left oculomotor and abducence nerve pareses. The radiating pain was thought to be an irritation sign of the left ophthalmic and maxillary nerves. Her visual acuity and field were normal.

A postcontrast computed tomographic (CT) scan showed bilateral homogeneously enhanced masses at the cavernous portion, the one on the left side being larger than that on the right (Fig. 1). Left carotid angiograms revealed a giant aneurysm extending...
over the petrosal and cavernous portions of the internal carotid artery and the well-developed superficial temporal artery (STA) (Fig. 2). Right carotid angiograms also showed a giant aneurysm extending over the petrosal and cavernous portions of the internal carotid artery and the well-developed STA. Horizontal portion of the left ACA is hypoplastic.

Both giant aneurysms were thought to be inaccessible and were planned to be treated by carotid ligation combined with an EC-IC bypass. The aneurysm on the left side was larger and symptomatic, so took precedence over that on the right side. Such procedures as the balloon Matas test to confirm the safety of carotid ligation were not performed, because we distrust the indications of such occlusion tests from our experience of one case who suffered cerebral ischemia, despite the negative result of a balloon occlusion test. The bilateral carotid arteries would eventually be ligated, so some kind of vascular reconstruction surgery should be performed prior to carotid ligation. We thought that an adequate blood flow would be obtained by STA-middle cerebral artery (MCA) double bypasses, because the bypass flow was only required to perfuse the left MCA territory and the left STA was well developed to provide an adequate blood flow.

The operation was carried out with continuous SEP monitoring (Fig. 4). Firstly, the frontal and parietal branches of the STA were anastomosed to the intra-Sylvian segments of the precentral and middle temporal arteries. Then, the left internal carotid artery was exposed and temporarily occluded at the cervical carotid bifurcation. No abnormality in SEP was observed 60 minutes after the carotid occlusion, so the internal carotid artery was ligated. However, 100 minutes after the carotid occlusion, during the dural closure and replacement of the bone flap, N20 abruptly disappeared. At this time, both STA-MCA double bypasses were found to be patent. The anesthetic condition and systemic blood pressure were both stable during the operation. The ligation of the internal carotid artery was released after irrigation with heparinized saline, which was followed by the rapid recovery of N20. This result suggested that the disappearance of N20 was caused by an insufficient blood flow to the cerebral tissues. Therefore, a high-flow bypass was installed from the

Fig. 1 Postcontrast CT scan, showing bilateral homogeneously enhanced masses at the cavernous portion.

Fig. 2 Left common carotid angiograms, anteroposterior (left) and lateral views (right), demonstrating a giant aneurysm extending over the petrosal and cavernous portions of the internal carotid artery and the well-developed STA. Horizontal portion of the left ACA is hypoplastic.

Fig. 3 Right carotid angiograms, anteroposterior (left) and lateral views (right), showing a giant aneurysm extending over the petrosal and cavernous portions of the internal carotid artery.

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external carotid artery to the posterior division of the MCA, interposed by a radial artery graft. The internal carotid artery was then ligated again at the cervical portion without any change in SEP. We were not satisfied with proximal ligation of the internal carotid artery alone, because the collateral vessels of the cavernous and petrosal portions might recanalize the thrombosed aneurysm, resulting in delayed embolic complications, and because the blood flow into the aneurysm could persist through the high-flow bypass even after the carotid ligation. Thus, trapping of the internal carotid artery was completed by clipping just proximal to the branching of the ophthalmic artery. The cavernous sinus was partially opened for this procedure, because the ophthalmic artery branched from the intracavernous portion of the internal carotid artery.

The postoperative course was uneventful. Her visual acuity and field remained normal. The left oculomotor and abducence nerve pareses disappeared in 3 weeks, and the pain in the forehead and cheek also disappeared. Left carotid angiograms taken 1 month after surgery showed that the patent high-flow bypass was perfusing both the left MCA and ACA and the aneurysm had completely disappeared. Both STA-MCA double bypasses were occluded (Fig. 5), although their patency had been confirmed by the pulsation of the STA and the transcranial Doppler method for 2 weeks after the operation. The much lower arterial pressure in the STA-MCA bypasses than that in the high-flow bypass might have occluded the STA-MCA bypasses. A postoperative single photon emission CT (SPECT) showed no change in cerebral blood flow (CBF) compared with the preoperative SPECT. She is being followed at the outpatient department with a plan of second operation for the aneurysm on the right side.

**Discussion**

Several methods for the treatment of inaccessible internal carotid aneurysms, such as ligation of the internal carotid or common carotid artery and trapping of the aneurysm using detachable balloon techniques, have been proposed. A major complication of these methods is cerebral ischemia due to the sacrifice of the internal carotid artery. EC-IC bypass is expected to prevent cerebral ischemia. However,
Ueda et al. suggested that the internal carotid artery dysfunctions as promptly as possible even under back pressure, EEG, and SEP can detect neurological dysfunctions. We therefore had failed to detect cerebral ischemia by both neurological and EEG examinations.) We therefore had failed to detect cerebral ischemia by both neurological and EEG examinations. To evaluate the safety of the internal carotid artery occlusion, angiographic demonstration of cross filling and manual compression of the common carotid artery (Matas test) have been performed preoperatively. But these methods are known not to be always reliable. Recently, a test occlusion of the internal carotid artery with a balloon catheter, the balloon Matas test, has been proposed. Some reports have described the usefulness of three-dimensional evaluation of the CBF by either dynamic CT or SPECT in combination with the balloon Matas test. However, it has not been established what length of time the test occlusion should be continued to confirm the safety of carotid ligation. When the occlusion test does reveal the possibility of cerebral ischemia, it has also not been established how much blood flow should be provided by the EC-IC bypass; in other words, which method of EC-IC bypass, STA-MCA bypass or high-flow bypass, should be selected.

Ueda et al. suggested that the internal carotid artery could be occluded safely, when neither neurological dysfunctions nor electroencephalographic (EEG) abnormality could be detected during the balloon Matas test. They performed a test occlusion initially for 3 minutes, and if the patient was normal during this period, continued it for more than 10 minutes. Test occlusion is usually performed prior to the permanent occlusion of the internal carotid artery with detachable balloons. In such cases, a 15-30-minute test occlusion is thought to be sufficient. However, as mentioned above, we experienced one case with ischemic symptoms after the trapping of internal carotid artery using detachable balloons, although a 30-minute test occlusion had failed to detect cerebral ischemia by both neurological and EEG examinations. We therefore doubt the reliability of such a test occlusion.

Intraoperative monitoring of the internal carotid artery back pressure, EEG, and SEP can detect neurological dysfunctions as promptly as possible even under general anesthesia. Takagi and Okumura reported that the occurrence of severe, abrupt cerebral ischemia was detected within 1 minute as a change in SEP, and the gradual decrease in CBF was correlated with a change in amplitude of SEP. Several reports have mentioned SEP monitoring during aneurysm surgery, where the major cerebral arteries are often temporarily occluded. According to Momma et al., disappearance of the N20 potential following occlusion is regarded as a danger signal, but the clinical outcome is expected to be good if the N20 potential recovers within 20 minutes after recirculation. Our review of the literature showed that the longest time from vascular occlusion to change in N20 potentials is the 50 minutes of Kidooka's case, in which proximal occlusion of bilateral ACAs were continued for 100 minutes and the SEP central conduction times were significantly prolonged 50 minutes after occlusion. According to Jones et al., the period and severity of the ischemia decide the degree of cerebral tissue damage, or whether the cerebral tissues remain intact. In our case, the cerebral ischemia was not so severe, because of the prior STA-MCA bypasses. Considering another factor related with the disappearance of SEP, the CBF may have decreased to below the critical level, either by increased blood viscosity or by brain transformation due to either brain retraction or cerebrospinal fluid drainage.

Generally speaking, collateral blood flow is thought to be sufficient in cases with normal SEP recording during a test occlusion of 15-30 minutes. In some cases, however, the collateral blood flow might be less than the critical level, and they could suffer from neurological dysfunction after a long period of occlusion, as in our case. In practice, it is difficult to extend the test occlusion over a long time, because the risk of thromboembolism becomes serious. At present, we should note the limited reliability of the test occlusion.

At present, there is no established method to decide how much blood flow should be re-established by the EC-IC bypass, when the test occlusion shows signs of cerebral ischemia. In our case, the STA-MCA double bypasses did not provide sufficient blood flow to compensate for the decrease caused by the carotid ligation. Therefore, our patient underwent high-flow bypass with a radial artery graft, that could supply a greater blood flow, achieving a satisfactory result. The shunt flow via the radial artery graft is about 100 ml/min, while that of the STA is about 30 ml/min. The radial artery graft is considered to be the most suitable method for cases in which the high-flow bypass is necessary.

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In the future, the quantitative evaluation of CBF using SPECT or positron emission tomography, combined with the balloon Matas test, will be a useful method to evaluate how much blood flow should be re-perfused, as well as which vascular reconstruction surgery should be chosen.

References


Address reprint requests to: T. Ishikawa, M.D., Department of Neurosurgery, Hokkaido University School of Medicine, North-15, West-7, Kita-ku, Sapporo 060, Japan.