Bypass Surgery for Occluded Internal Carotid Artery
Revascularized by Vasa Vasorum

—Case Report—

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Abstract

A 47-year-old woman presented with two transient ischemic attacks due to occlusion of the left internal carotid artery. The affected artery was revascularized by vasa vasorum. Angiography showed occlusion of the left common carotid artery including the origin of the internal carotid artery. The distal internal carotid artery was revascularized by vasa vasorum at the level of the second cervical vertebral body. Left subclavian artery-internal carotid artery bypass surgery using a saphenous vein graft was performed successfully, during which the narrowed but patent lumen of the internal carotid artery was confirmed. Follow-up angiography showed enlargement of the left internal carotid artery distal to the patent bypass. Reconstructive bypass surgery is a possible treatment for patients with occluded internal carotid artery revascularized by vasa vasorum. Angiographic detection of the lumen of the internal carotid artery is important for surgical consideration.

Key words: bypass surgery, carotid artery, revascularization, vasa vasorum

Introduction

Vasa vasorum occur in the walls of medium to large arteries. Vasa vasorum in the cervical carotid arteries are thought to originate from the terminal branches of the occipital and posterior auricular arteries and the internal carotid artery near the bifurcation, and to supply the adventitia and outer third of the media. Atherosclerotic changes cause an increase in vasa vasorum to form a dense vascular network within the plaques. In addition, vessels originating from the arterial lumen may develop and communicate with the network. Inflammatory processes of the arterial wall may also contribute to a similar increase in vasa vasorum.

Angiographic evidence has shown that the vasa vasorum can provide collateralization to previously occluded internal carotid arteries. All cases were treated conservatively, except one case in which carotid endarterectomy was performed to find that the internal carotid artery was occluded at its origin.

We treated a patient with occluded internal carotid artery that was revascularized by the vasa vasorum. Direct bypass surgery was performed. The operative finding showed that the lumen of the internal carotid artery was actually patent and the postoperative course indicated that the surgical bypass flow improved anterograde cerebral blood flow (CBF).

Case Report

A 47-year-old woman with a history of hypertension and contraceptive agent use until the age of 37 years presented with two transient ischemic attacks manifesting as right hemiparesis and aphasia occurring 10 and 2 months previously. On admission she had no neurological deficit. Routine blood examination revealed slight liver dysfunction, moderate hyperlipidemia, and slight elevation of C-reactive protein. Further serological examination detected mild positive reactions for antinuclear antibody, anticardiolipin immunoglobulin G antibody, and lupus anticoagulant. There was a bruit over the right subclavian artery. Rheumatic disease very similar to Takayasu arteritis was considered, but no definitive
Fig. 1 A: Digital subtraction aortogram showing mild stenosis at the origin of the left subclavian artery, occlusion of the left vertebral artery at its origin, occlusion of the left common carotid artery 2 cm above its origin (arrow), and moderate stenosis of the right vertebral artery origin. B: Right common carotid angiogram showing right to left collateral flow via the anterior communicating artery. C: Left subclavian angiogram, late arterial phase, demonstrating marked collateral flow from the deep and the ascending cervical arteries had reconstructed the left occipital artery, and flowed retrogradely into the external carotid artery. The arrow indicates the occipital artery near the point at the crossing of the internal carotid artery. The same collateral flow also filled a fine network or multiple serpentine channels around the presumed internal carotid artery (white arrowhead). The network opacified the distal internal carotid artery approximately at the level of the second cervical vertebral body. The anterograde flow in the internal carotid artery continued to the intracranial arteries, although the opacification was weak (Fig. 1D).

Single photon emission computed tomography (SPECT) using xenon-133 demonstrated marked reduction of perfusion in the entire left cerebral hemisphere at rest and after acetazolamide (1 g, intravenous injection) challenge (Fig. 2A, B).

Marked flow reduction manifesting as transient ischemic attacks, her relatively low age, and possibly progressive pathology due to the similarity to arteritis prompted us to consider surgical intervention. Since angiography suggested that the transition from the vasa vasorum to the lumen of internal carotid artery occurred at the point from the serpentine vessels to the narrow but rather smooth single lumen which was surgically accessible, we performed bypass surgery using a saphenous vein graft between the left subclavian and internal carotid arteries. Nineteen days prior to the surgery, percutaneous transluminal angioplasty for the right common carotid artery stenosis was performed to minimize the risk of ischemia in the left hemisphere during the surgery.

First, the left cervical carotid arteries were exposed in the usual manner. Pulsation of the common carotid artery was absent and the arterial wall was pale, although the external size of the artery appeared normal. Moderate proliferation of the fine vessels was seen in the connective tissue behind the internal carotid artery, corresponding to the anatomic finding (Fig. 3). The connective tissue behind the internal carotid artery was left intact to preserve the blood flow from the vasa vasorum to the internal carotid artery until a temporary clip was applied subsequently. Heparin (5000 IU) was administered intravenously and the left internal
carotid artery was temporarily clipped at the site as distal as possible (approximately the second cervical vertebral body level, presumably distal to the entrance of the vasa vasorum into the internal carotid artery). The arterial wall was then incised to confirm the presence of the true lumen of the internal carotid artery. The wall of the internal carotid artery was markedly thick (approximately 1.5 mm in thickness). The lumen was consequently greatly narrowed, but weak back flow from the distal internal carotid artery was present. The opening of the vasa vasorum could not be seen from the lumen. The saphenous vein graft, taken from the right lower extremity, was passed through the subcutaneous tunnel just above the sternocleidomastoid muscle. The left subclavian artery was incised and showed marked, smooth wall thickening very similar to the findings in the internal carotid artery. A small specimen of the incised arterial wall was taken for histological examination. The end-to-side anastomoses of the graft were performed with the left subclavian artery and the internal carotid artery in this order using 6–0 and 7–0 prolene sutures, respectively.

Histological examination of the subclavian arterial wall specimen demonstrated marked fibrous thickening of the intima, proliferation of collagen fibers in the outer media, and mild invasion of lymphocytes around the adventitia. The histological diagnosis was inflammation and fibrosis.

Since the preoperative flow reduction in the left hemisphere was severe and a high flow bypass was used, we considered that the patient had the risk of hyperperfusion syndrome in the early postoperative stage. Therefore, the blood pressure was meticulously controlled so that the systolic blood pressure remained at 100–130 mmHg measured by invasive arterial pressure. Despite this strict blood pressure control, N-isopropyl-[[123I]iodoamphetamine SPECT demonstrated mild hyperperfusion in the entire left hemisphere on the 1st and 3rd postoperative days. Blood pressure control was continued for the next 3 days and then slowly allowed to return to the

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preoperative level.

The further postoperative course was uneventful. Angiography performed 2 weeks postoperatively demonstrated the widely patent graft and enlarged left internal carotid artery system (Fig. 4). Xenon-133 SPECT 3 weeks after the surgery demonstrated restoration of CBF in both the resting state and after acetazolamide challenge (Fig. 2C, D). The patient was discharged on the 26th postoperative day with no neurological deficit. Magnetic resonance angiography 6 months after the surgery showed good patency of the graft and no recurrent stenosis in the cerebral arteries.

Discussion

The pathological angiographical findings of vasa vasorum were recently shown to be a consequence of collateralization or revascularization of a previously occluded carotid artery.\(^5\) Eight patients demonstrated carotid string-like angiographical findings associated with ipsilateral carotid artery occlusion, in contrast with the so-called carotid string sign,\(^6\) because single or multiple serpiginous channels were seen instead of a single linear or curvilinear contrast string.\(^9\) One patient underwent carotid endarterectomy.\(^9\) Angiography of this surgical case detected a small tortuous vessel arising from the common carotid artery, and continuing distally to opacify the markedly thinned distal internal carotid artery. During surgery, the small vessel was identified as a branch within the wall of the internal carotid artery and the internal carotid artery was completely occluded. However, the surgical manipulation was limited to the portion of the vasa vasorum at the occluded internal carotid artery and not the distal internal carotid artery.

In the present case, the angiographical lumen of the internal carotid artery fed by the vasa vasorum was confirmed to be the true lumen. Angiography could distinguish the increased vasa vasorum and the thinned lumen of the artery: increased vasa vasorum usually appears as multiple and tortuous vessels, whereas the thinned lumen is single and relatively straight and smooth. This angiographical distinction is considered to be one of the keys for the success of surgical intervention. We found that the narrowed internal carotid artery was still an effective recipient for surgical revascularization, although hyperperfusion due to widening of the artery was observed on SPECT early after the surgery.

Four previous patients were considered to have adequate collateral circulation and were treated conservatively.\(^5,9\) However, the judgment basis seemed obscure. CBF examination is necessary for evaluation of the adequacy of the collateral circulation. In the present case, we used quantitative SPECT to evaluate the CBF including reserve capacity. The results demonstrated marked flow reduction in the ipsilateral hemisphere, in spite of the angiographical collateral flow from the anterior and posterior communicating arteries as well as the vasa vasorum. In fact, the presence of low blood supply from the vasa vasorum may imply severely impaired perfusion status in spite of the other collaterals.

Our case may have a different pathogenesis of the carotid artery occlusion from the previously reported cases. Our case presented with several suggestive findings of vasculitis or arteritis similar to Takayasu's disease, whereas most previous cases had an atherosclerotic nature.\(^5,9\) The inflammatory process of the large arteries in Takayasu's disease and related arteritis may affect the outer layers of the walls supplied by the vasa vasorum and vasa vasorum may emerge in the media and the intima of the inflamed arteries.\(^7,12,13\)

There is some controversy about whether bypass surgery including the subclavian artery is effective against arteritis like Takayasu's disease in terms of long-term outcome of the patient. Although we performed bypass surgery because the patient had recurrent ipsilateral transient ischemic attacks and because the subclavian artery was relatively well preserved, long-term follow up is mandatory. Nevertheless, the present case suggests that direct bypass surgery may be an effective treatment option in patients with occluded carotid artery revascularized...
by vasa vasorum.

References


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