Collateralization of an Occluded Internal Carotid Artery Via a Vas Vasorum

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Background—Reopening of an occluded internal carotid artery (ICA) is often seen in dissections but only rarely occurs in atherothrombotic occlusion of the internal carotid artery.

Case Description—A 60-year-old man suffered a minor stroke with dysphasia in March 1995. Color-coded duplex ultrasonography of his neck arteries revealed a left ICA occlusion. He was placed on a regimen of aspirin and followed up clinically and with ultrasonography. At follow-up 18 months later, the patient was asymptomatic. On duplex ultrasonography his left occluded ICA was found to be reopened, with a residual, proximal, high-grade stenosis. However, intra-arterial digital subtraction angiography demonstrated a persistent ICA occlusion and a vas vasorum originating from the carotid bulb and draining into the ICA distal to the occlusion.

Conclusions—The rare collateralization of an occluded ICA by vasa vasorum seems to take several months. It can be a pitfall in the ultrasound diagnosis of carotid artery occlusive disease. (Stroke. 1998;29:521-523.)

Key Words: carotid arteries • occlusion • ultrasonography • angiography

Reopening of a previously occluded internal carotid artery (ICA) is seen primarily in dissections and only rarely in atherosclerotic disease of the internal carotid artery.1,2

The adventitia and the outer media of the carotid artery are supplied by vasa vasorum, whereas the intima and the inner media are nourished by diffusion from the lumen. Vasa vasorum arise directly from the lumen of the ICA or originate from the superior thyroid and ascending pharyngeal arteries.3 Proliferation of vasa vasorum into atherosclerotic plaques has been described, which indicates their potential ability to remodel the anatomy of the patient’s artery.3,4

Searching the literature revealed only two reports of “revascularization” of an occluded ICA via vasa vasorum.5,6 In both cases angiography demonstrated that the vas vasorum had originated from the carotid bulb and bypassed the ICA occlusion by filling the distal ICA downstream from the lesion.

Color-coded duplex ultrasonography is a valid diagnostic tool in the assessment of ICA stenosis and occlusion.7,8 Color mode uses multiple sample volumes, in which the different velocities of the moving blood are represented by different colors. The color mode is superimposed onto conventional B-mode imaging. However, the differentiation of occlusions and pseudo-occlusions may occasionally pose problems despite the use of echocontrast media.7,8,10

Case Report
A 60-year-old man with a history of hypertension had a minor stroke with transient dysphasia in 1995. Physical examination was otherwise unremarkable. A cranial CT scan showed small infarctions in the white matter of the left hemisphere and a left parietal cortical atrophy. Ultrasound investigation of the neck arteries with color-coded duplex ultrasonography and of the large basal arteries of the circle of Willis with transcranial Doppler ultrasonography showed an occlusion of the left ICA with slight reduction of flow velocity in the upstream common carotid artery, moderately reduced flow velocity of the ipsilateral middle cerebral artery, and sufficient right-to-left cross-flow via the anterior communicating artery. The left supratrochlear artery showed retrograde flow, and there were additional plaques in the right carotid bulb. The patient was placed on a regimen of 300 mg aspirin daily. A repeat duplex investigation in September 1995 showed no changes, with the patient remaining free of symptoms.

Eighteen months later, in October 1996, color duplex scanning of the carotid arteries was repeated. This time the duplex investigation revealed a thin (1.5 mm in diameter) vascular channel, originating from the carotid bulb and filling the distal ICA. This blood vessel showed marked tortuosity (Fig 1, top). Within its proximal lumen, the maximum angle-corrected systolic/diastolic velocities were 280/100 cm/s with poststenotic turbulences but were 60/25 cm/s in the distal lumen of the ICA. There was still a reduced flow velocity within the left common carotid artery, retrograde flow in the left supratrochlear artery, and a right-to-left cross-flow in the anterior communicating artery. The diagnosis of a revascularization of the ICA occlusion with a residual high-
grade ICA stenosis was made on the basis of these ultrasound finding.

Source images and maximum intensity reconstructions of a 3D time-of-flight MR angiography (MRA) (Magneton Impact Expert, Siemens AG/Germany; repetition time, 30 ms; echo time, 10 ms; flip angle, 10°; field of view, 175×200 mm; matrix, 200×256; acquisition time, 6.5 minutes) showed persistent occlusion of the left ICA. Transfemoral intra-arterial digital subtraction angiography also demonstrated a persistent occlusion of the ICA but revealed a thin vessel originating from the carotid bulb and filling the distal ICA (Fig 2). Intra-arterial angiography confirmed the cross-flow from right to left via the anterior communicating artery.

Repeat duplex investigation (Sonos 2500, Hewlett Packard/USA; 7.5-MHz linear assay probe with 5.5-MHz pulsed-wave Doppler mode), in view of the angiographic findings, revealed a long lumen 2 mm in diameter and with marked tortuosity, a somewhat unusual finding in arteriosclerotic occlusions. On transverse color-coded sections 1.5 cm distal to the bifurcation, we could not reliably distinguish whether the lumen was inside the carotid artery, adjacent to its wall, or inside the vessel wall itself; in some scans it seemed to be inside the original lumen (Fig 1, bottom).

Discussion
Collateralization of a previously occluded ICA via a vas vasorum is an extremely rare event, with only two reported cases.\textsuperscript{5,6} Development of the “revascularization” of an ICA

**Figure 1.** Color-coded duplex ultrasonography of the vas vasorum, longitudinal (top template) and transverse sections, level 1.5 cm above the bifurcation (bottom template).

**Figure 2.** Intra-arterial digital subtraction angiography of the occluded internal artery with the vas vasorum in the early (top template) and late (bottom template) filling phases. The vas vasorum originates from the left carotid bulb and fills up the distal internal carotid artery.
occlusion by a vas vasorum seems to require several months. It may be misdiagnosed by duplex ultrasonography as the “stenosis” of a recanalized ICA occlusion, even if color-coded ultrasound is applied. With regard to therapy, the accurate differentiation between occlusion and high-grade stenosis is critical because there is no benefit of surgery in carotid occlusion.\(^2\)\(^,\)\(^8\) A recent report suggests that carotid endarterectomy may be performed solely on the basis of the noninvasive color-coded duplex investigation, without preoperative selective intra-arterial angiography.\(^8\) The value of color-coded duplex ultrasound and MRA is debated. The somewhat unexpected finding of increased flow velocity at the origin might be explained by a functional stenosis. The location of this vessel seemed in some scans to be inside the original lumen, which could be explained by intraluminal neovascularization. Whereas some investigators recommend the combination of duplex scan and MRA, others have reservations because MRA may not allow for the differentiation of high-grade stenoses and occlusions.\(^8\)\(^,\)\(^11\) In our case, the thin vessel detected by duplex scan had not been visualized by time-of-flight MRA. Additional noninvasive technique such as helical CT would have been useful to separate the enhanced arterial lumen from the arterial wall.

Features that may help to differentiate this rare condition from a genuine stenosis are the uniformly narrow, long lumen and the corkscrew-like tortuosity of the vas vasorum. However, confirmation can be achieved only by selective intra-arterial angiography.

This case shows that patients with atypical findings at the carotid bulb, particularly those with a previously proved but seemingly recanalized occlusion of the ICA, should not be undergo surgery without prior intra-arterial angiography.

References
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