Ultrasonic Demonstration of External and Internal Carotid Patency with Common Carotid Occlusion: A Preliminary Report

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SUMMARY Non-invasive ultrasonic imaging of the carotid bifurcation by duplex scanning and ultrasonic arteriography combined with pulsed Doppler spectrum analysis demonstrated patency of the external and internal carotid arteries distal to a common carotid occlusion in 3 patients. Common carotid occlusion is not invariably associated with thrombosis of the ipsilateral internal carotid artery. Identification of internal carotid patency by the use of ultrasonic techniques will permit surgical treatment in selected cases.

CHRONIC OCCLUSION of the carotid arteries in most patients is not amenable to surgical correction.6-8 Occlusion of the common carotid artery (CCA) is usually accompanied by propagation of the thrombus into the external (ECA) and internal carotid (ICA) arteries. Fear of dislodging clot during operative manipulations, and producing an embolic stroke, has prompted most vascular surgeons to avoid operative intervention. However, if patency of the external and internal carotid arteries is maintained by collaterals in the face of an occluded common carotid, a subclavian-carotid or carotid-carotid bypass may relieve symptoms of cerebral hemispheric ischemia.4

While this situation undoubtedly occurs, demonstration of the patent ECA and ICA by angiography has usually not been attempted since the condition is considered to be quite uncommon. In this report we describe 3 patients in whom ICA and ECA patency with an ipsilateral CCA occlusion was identified non-invasively by ultrasonic imaging and pulsed Doppler techniques, prompting operative exploration in one case.

Materials and Methods

Non-invasive carotid evaluation was performed by duplex scanning and ultrasonic arteriography* combined with pulsed Doppler spectrum analysis.† The pulsed Doppler has the ability to detect flow from a small point in tissue, called the sample volume or gate, whose location can be adjusted by the examiner. The duplex scanner combines real time B-mode arterial imaging with pulsed Doppler flow velocity evaluation.5 The ultrasonic arteriograph employs a 6-gated pulsed Doppler to construct a flow map of the carotid vessels.6,7 This map is then used as a guide from which the characteristics of flow with a single pulsed Doppler gate can be assessed. Forward and reverse flow are separated by phase rotation with both of these techniques.8 Spectrum analysis provides a hard copy output of the frequency content of the pulsed Doppler signals, yielding quantitative information relative to the velocity and direction of flow and also to the degree offlow disturbance within the pulsed Doppler sample volume.

Arterial occlusions are diagnosed with the duplex scanner by failure to detect flow with the sample volume positioned within the lumen of an imaged vessel (fig. 1). Common and internal carotid occlusion is identified with the ultrasonic arteriograph by failure to detect their characteristic high mean flow signal in the usual location immediately adjacent to the internal jugular vein signal (fig. 2). Disturbed flow is demonstrated on spectrum analysis by opacification of the area under the systolic peak. With severe flow disturbances, simultaneous forward and reverse flow can be seen (fig. 3A).9,10

Patient Reports

Patient 1 — E. F., a 57-year-old white male, was admitted to the University of Washington Hospital shortly after the onset of aphasia and mild right hemiparesis. These symptoms slowly improved over the next several days, and 5 days after admission he was referred for carotid evaluation. Duplex scan revealed an occluded right internal carotid and also an occluded left common carotid (fig. 1). At the left carotid bifurcation, the ECA and ICA were identified and flow was detected in each vessel. The direction of flow in the ECA was reversed, flowing into the carotid bulb, from where it proceeded in a cephalad direction via the ICA.

Subsequent arch angiography confirmed the right ICA and left CCA occlusions. Because of the findings on duplex scanning, subtraction views of the late films
were obtained, although the left carotid bulb could not be seen on the routine films. These studies demonstrated the left carotid bulb filling by retrograde flow through branches of the left ECA (fig. 4). The left ICA could not be definitely identified, although the left vertebral artery was superimposed.

Since the patient had suffered a completed stroke, he was discharged but returned 2 months later for a left neck exploration. A subclavian-carotid bulb vein bypass graft was planned if the ICA was found to be patent. At operation the left ECA and bulb were open but soft thrombus had propagated from the common carotid up into the ICA. This clot was removed from the lower portion of the ICA but no back-bleeding was obtained from distally. Accordingly, the vessel was closed without bypass. Postoperatively, the patient's neurologic condition was unchanged.

**Patient 2** — J. V., a 66-year-old white male, was referred for carotid evaluation because of intermittent episodes of confusion and tremors in the right arm and leg associated with an absent left carotid pulse. Ultrasonic arteriography failed to detect a left common carotid signal; however, a patent left carotid bulb was identified filling retrograde from the left ECA. The left ICA was patent with forward flow (fig. 2). The right carotid system was essentially normal. These findings were confirmed by duplex scan and spectrum analysis.

The patient was advised to undergo carotid arteriography but refused. Subsequent follow up revealed that the frequency of the tremors has decreased.

**Patient 3** — W. M., a 66-year-old white male diabetic was referred to the UWH carotid lab from a diabetic vascular disease study in which he was participating. A marked change had been noted in the results of indirect non-invasive carotid studies suggesting progression of left carotid disease, although the patient was asymptomatic. Duplex scan revealed occlusion of both the right ICA and the left CCA. An abnormal Doppler signal was detected in the left carotid bulb. Spectrum analysis of this signal revealed evidence of marked flow disturbance and bidirectional flow (fig. 3A). Reversed flow in the ECA (fig. 3B) and forward flow in the ICA (fig. 3C) were also identified. These findings were confirmed by ultrasonic arteriography. Because the patient was asymptomatic, his primary physician elected not to pursue further diagnostic work-up.

**Discussion**

When an artery is acutely thrombosed, the clot most often propagates distally to the level of the next large re-entry collateral. This situation is commonly seen with common iliac artery occlusion in the lower extremity where patency of the ipsilateral internal and external iliac arteries can be maintained by cross-pelvic collaterals from the contralateral internal iliac artery. The 3 patients in this report clearly demonstrate that this mechanism may also operate with common carotid occlusions if the collateral flow from the contralateral external carotid artery is adequate and if intracranial collaterals are deficient.

In the first and third patients the left CCA occlusion was associated with a contralateral ICA occlusion. The path of least resistance to flow for the anterior in-
tracranial circulation was probably the right ECA to left ECA collateral anastomoses. The subsequent asymptomatic propagation of thrombus into the left ICA in the first patient, which most likely occurred in the interval between the non-invasive evaluation and the arteriogram, may well have been due to stasis in this vessel induced by increasing intracranial collateral flow from the large left vertebral artery. Unfortunately, a preoperative duplex scan was not performed on the second admission in the first patient. If the internal carotid occlusion could have been demonstrated, then perhaps an unnecessary operation could have been avoided.

In the second patient the contralateral carotid
system was essentially normal; however, the symptoms suggest that intracranial collateral flow to the left cerebral hemisphere was deficient. These circumstances again favored the preservation of left ICA perfusion by ECA to ECA collaterals.

The patients in this report demonstrate that CCA occlusion is not invariably associated with propagation of the thrombus into the internal carotid artery. In each patient ultrasonic imaging and pulsed Doppler techniques identified retrograde filling of the ICA via the ECA, a situation which may be more common than previously thought, since it is difficult to demonstrate angiographically. In one patient this retrograde flow pattern in the ECA was confirmed angiographically, although the ICA had probably thrombosed by the time of the study. Judicious use of non-invasive ultrasonic techniques in symptomatic patients with common carotid occlusion can identify those instances in which patency of the distal vessels is maintained. After confirmation of these findings by late subtraction angiograms, carotid-carotid or subclavian-carotid bypass may then provide relief of symptoms of cerebral ischemia in selected cases.

References

Cardiovascular Mortality in Transient Ischemic Attacks
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SUMMARY Statistical analyses were made of the mortality of persons diagnosed as having definite TIA in an epidemiologic survey of a biracial Southern community. None of the usual risk factors associated with this illness such as heart disease, hypertension or diabetes appears to account for the excess deaths observed in a 10 year period of follow up.

THE MORTALITY RATE of patients with transient cerebral ischemic attacks (TIA) has been found to be considerably greater than that of the general population of comparable age and sex.1,2 Although the increase in mortality in TIA is usually attributed to the presence of associated factors such as hypertension, diabetes or heart disease, there have been few attempts to quantify the relative significance of these conditions. The purpose of the present paper is to determine by means of statistical analyses which, if any, of these concomitant risk factors contribute to the high death rate from TIA.

Patients and Methods
The study population consists of residents of Evans County, Georgia, a small rural community in the high stroke belt of the Southeastern United States.3 The initial survey of this community comprising approximately 60% White and 40% Black population...
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