

FIGURE 2. Fundus photos showing the resolution of multifocal central serous chorioretinopathy 3 months later. There were retinal pigment epithelial changes over the maculae.

the choroidal vasculature, which leads to choroidal hyperpermeability and the subsequent development of multifocal CSCR. Similar immune-related conjunctival chemosis and CSCR have been noted in lupus patients.⁵ In summary, GVHD may contribute to the development of CSCR in post-BMT patients.

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In Situ Confirmation of Retinal Blood Flow Improvement After Carotid Endarterectomy in a Patient With Ocular Ischemic Syndrome

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PURPOSE: To report a patient with ocular ischemic syndrome due to an internal carotid artery stenosis in whom we confirmed improved retinal blood flow noninvasively after carotid endarterectomy.

DESIGN: Observational case report.

METHODS: Retinal flowmetry.

RESULTS: In a 72-year-old hypertensive man with a transient ischemic attack including dysgraphia, carotid angiography revealed approximately 90% stenosis of the left internal carotid artery. Standard carotid endarterectomy was performed. Postoperatively, good patency of the left internal carotid artery was confirmed by magnetic resonance angiography. We measured tissue blood flow in the fundus of each eye using a Heidelberg retina flowmeter before and after endarterectomy. Preoperative measurements showed reduction of blood flow in the left fundus, while values 3 months after surgery indicated a significant improvement of blood flow ($P < .05$, one-factor analysis of variance [ANOVA]).

CONCLUSIONS: Retinal flowmetry can noninvasively detect differences in retinal blood flow between eyes in a patient with unilateral internal carotid artery stenosis and also assess the improvement of retinal blood flow after carotid endarterectomy. (*Am J Ophthalmol*)

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THE HEIDELBERG RETINA FLOWMETER (HRF; HEIDELBERG Engineering GmBh, Heidelberg, Germany) is a recently developed instrument for noninvasive measurement of retinal blood flow. Reproducible quantification of capillary blood flow is now possible in distinct areas of the capillary meshwork of the retina and the optic nerve head.¹ We present a case of ocular ischemic syndrome (OIS) due to a left internal carotid artery stenosis. A difference in retinal blood flow between the two eyes was confirmed before carotid endarterectomy (CEA) by HRF and an improvement of blood flow was observed after CEA.

A 72-year-old man with hypertension presented with a transient ischemic attack including dysgraphia in the beginning of June 2000. Carotid angiography revealed approximately 90% stenosis of the left internal carotid artery (Figure 1A) on July 31, 2000. Best-corrected visual acuities were 20/20 in both eyes (OU) and the intraocular pressure was 14 mm Hg in both eyes (OU). Ophthalmoscopy showed punctate hemorrhages in the midperiphery of the retina in the left eye. Fluorescein angiography revealed a delayed arm-to-retina circulation time (53.3 seconds) in the left eye.

Tissue blood flow was measured five times in each of four retinal areas in both eyes by HRF, including the superior and inferior disk rim areas and the superior and inferior paramacular areas. We analyzed the data using an automatic full-field perfusion image analyzer (version 3.3, Heidelberg Engineering GmBh, Heidelberg, Germany).² Mean blood flow in each area was obtained by averaging the five values (Table 1). The ratio of the mean blood flow of the affected eye to the fellow eye (a/f) was calculated for each area to minimize the intervariation of a series of examinations. The ratio of the mean blood flow between the two eyes in normal subjects in the superior paramacular area was 0.99 ± 0.13 and the mean in the inferior paramacular area was 1.02 ± 0.12 .³ The preoperative a/f ratios were 0.70, 0.71, 0.83, and 0.87 in the same areas suggesting a reduction of blood flow in the left eye (Figure 1C).

On September 7, 2000, a standard CEA was performed. Postoperatively, good patency of the left internal carotid artery was confirmed by magnetic resonance angiography (Figure 1B) on January 12, 2001. The a/f ratios determined 3 months after the surgery were significantly better than preoperatively ($P = .04$ mean of four areas; one-factor analysis of variance [ANOVA]; Figure 1C).

CEA is the best treatment for the removal of a stenotic lesion from the internal carotid artery. Peak systolic flow velocity in the ophthalmic artery^{4,5} and retinal artery⁴ have been shown to increase by color

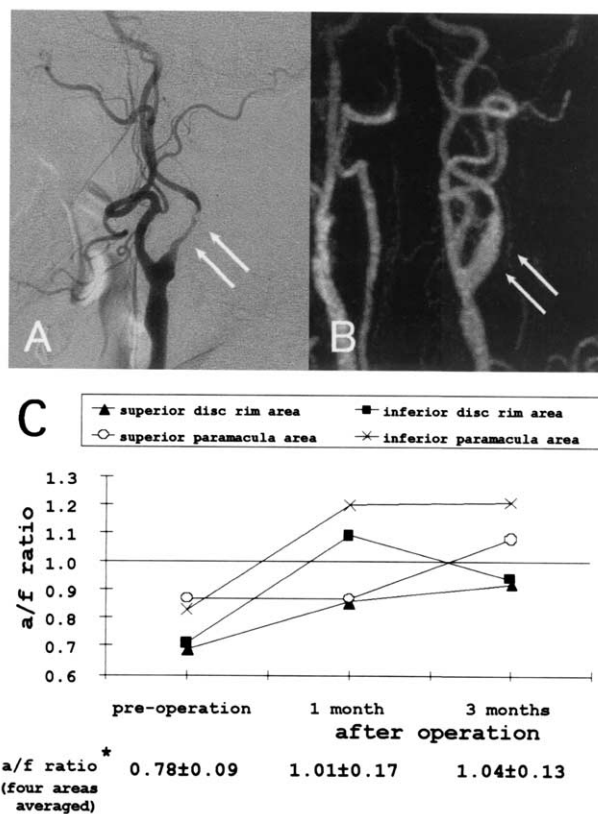


FIGURE 1. Angiographic imaging. (A) Preoperative left carotid angiogram demonstrating approximately 90% stenosis of the left internal carotid artery (arrows). (B) Postoperative left-side magnetic resonance angiographic image showing good patency of the left internal carotid artery (arrows). (C) Ratios of retinal tissue blood flow in the affected eye to those in the fellow eye (a/f) before carotid endarterectomy and at 1 and 3 months afterward. Ratios indicate a significant improvement of blood flow 3 months after surgery. *, $P = .04$, one-factor analysis of variance (ANOVA).

Doppler flow imaging following CEA. We demonstrated a postoperative improvement of retinal tissue blood flow by HRF.

The chronic type of OIS is caused most often by carotid artery disease and may lead to permanent blindness secondary to neovascular glaucoma.⁴ Early diagnosis of OIS is needed to prevent such an event. Many patients with internal carotid artery stenosis are elderly and may have poor systemic medical condition. In such patients, HRF can provide accurate information concerning ocular tissue blood flow noninvasively and easily before proceeding to carotid angiography or magnetic resonance angiography. Furthermore, HRF should be useful in evaluating the effect of CEA in a patient with OIS.

TABLE 1. Five Blood Flow Calculations by Heidelberg Retina Flowmeter at Four Retinal Areas Before and After Endarterectomy

	Disk Rim Area				Paramacular Area			
	Superior		Inferior		Superior		Inferior	
	Fellow Eye	Affected Eye	Fellow Eye	Affected Eye	Fellow Eye	Affected Eye	Fellow Eye	Affected Eye
	250.1	139.1	230.2	156.4	180.3	162.9	212.0	190.0
	253.4	194.0	245.2	158.5	192.4	168.2	235.9	195.8
Pre-operation	279.2	198.3	254.8	178.6	200.0	173.0	261.1	208.2
	280.5	204.8	268.6	215.7	207.6	177.6	285.8	211.8
	292.9	214.1	302.9	221.1	222.8	194.1	290.6	223.7
mean ± SD	271.2 ± 18.6	190.1 ± 29.5	260.4 ± 27.6	186.0 ± 30.8	200.6 ± 16.0	175.2 ± 11.9	248.7 ± 31.9	205.9 ± 13.3
	228.6	187.0	156.1	137.5	187.5	168.6	181.2	216.0
1 month after operation	259.0	214.1	159.2	188.1	195.2	175.0	188.2	219.1
	270.6	221.4	175.2	194.5	203.2	179.2	195.6	222.7
	280.1	237.6	200.8	213.8	205.1	179.2	199.7	223.0
	286.5	292.7	233.6	274.4	239.0	192.7	200.5	277.6
mean ± SD	264.9 ± 22.8	230.6 ± 39.3	185.0 ± 32.4	201.7 ± 49.5	206.0 ± 19.7	179.0 ± 8.8	193.0 ± 8.2	231.7 ± 25.8
	385.8	369.2	313.7	291.3	426.1	414.2	440.6	541.5
3 months after operation	398.4	406.3	359.9	315.8	433.3	472.5	485.5	581.4
	428.6	447.8	364.0	338.2	471.2	508.3	509.1	623.2
	547.9	482.9	375.5	385.2	511.8	575.2	535.1	646.7
	610.0	497.9	427.3	392.6	530.7	594.4	548.3	652.5
mean ± SD	474.1 ± 99.4	440.8 ± 53.4	368.1 ± 40.7	344.6 ± 43.8	474.6 ± 46.4	512.9 ± 74.0	503.7 ± 42.8	609.0 ± 47.0

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