Inefficacies of the Doppler Ophthalmic Test (DOT) in Post-Endarterectomy Evaluation

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SUMMARY In an effort to evaluate the effectiveness of the Doppler Ophthalmic Test (DOT) following carotid endarterectomy, a large group of patients was examined both pre- and postoperatively with non-invasive techniques. The DOT, which has proven to be a useful non-invasive diagnostic test for the determination of significant carotid artery stenosis, was found to be persistently abnormal in 46% of patients with a preoperative positive test. This occurred in spite of the fact that operative arteriography, direct ultrasonic auscultation, and Doppler imaging studies were all within normal limits. It is suggested from this study that the Doppler Ophthalmic Test alone is not adequate to follow patients postoperatively, especially if an abnormal study persists following a satisfactory endarterectomy. Other non-invasive techniques, which employ direct ultrasonic imaging of the carotid flow, may be more accurate in determining vessel patency.

Stroke Vol 10, No 4, 1979

Methods

During a 6 month period, 500 patients were studied in the Vascular Laboratory at the Green Hospital of Scripps Clinic by the Doppler Ophthalmic Test. A variety of clinical symptoms prompted the examination, including a history of cerebrovascular accidents, transient ischemic attacks, and amaurosis fugax. In addition, patients with non-specific complaints such as dizziness and patients with asymptomatic carotid bruits were referred for evaluation. Approximately 10% of the patients were referred for arch angiography and selected carotid artery arteriograms as a result of the Doppler Ophthalmic Test, and of this group 19 underwent unilateral carotid endarterectomy and 2 underwent bilateral procedures.

The Doppler Ophthalmic Test was performed with a Parks directional Doppler flowmeter (Model 906), equipped with both a 5.4 and 9 MHz pencil probe transducer (fig. 1). Velocity was monitored in the supraorbital artery and, after a stable tracing, the superficial temporal artery was manually compressed. Augmentation of supraorbital artery flow with superficial temporal artery compression (DOT I) was considered normal, and no change in flow (DOT III) was considered equivocal. If flow was obliterated with superficial temporal artery compression (DOT II) or if flow reversal (DOT IIA) occurred, the study was considered positive for carotid artery occlusion or stenosis.

All carotid operations were carried out with general anesthesia and adequacy of cerebral perfusion was estimated by measurement of carotid artery stump pressure. If the value of the stump pressure was 50 mm Hg or greater, no internal shunt was used, and if less, cerebral perfusion was maintained by use of an internal shunt. All patients underwent operative angiography at the completion of the endarterectomy to assure patency and the absence of an intimal flap. Postoperatively, all patients underwent repeat Doppler Ophthalmic Tests with direct ultrasonic auscultation and imaging of the carotid arteries, as advocated by Spencer (fig. 2).

Results

Twenty-one patients underwent carotid endarterectomy and 2 of these had a second side operated on within a week of the first operation. Twenty-three endarterectomies were performed in total. Table 1 shows the pre- and postoperative results of the DOT. Thirteen patients (15 carotids) had an abnormal preoperative examination, 6 patients had a normal examination, and 2 patients had an equivocal examination (not shown in table). Postoperatively all 6 patients with a normal preoperative examination remained normal. Of the 15 abnormal preoperative examinations 7 remained abnormal in the postoperative state and 8 reverted to normal at the time of the first postoperative examination. One patient with an abnormal preoperative examination continued to be abnormal for 1½ months postoperatively.
restudied 14 months postoperatively, the test had reverted to normal (table 2).

In each instance, patency of the endarterectomized segment was confirmed by examining the operative angiogram and recording postoperative direct ultrasonic imaging of the carotids from the supra-clavicular area to the mandibular area. There was no evidence of any abnormality in these studies other than some minor residual postoperative flow turbulence secondary to the operative procedure itself (fig. 3).

The presence of collaterals to the supraorbital artery was demonstrated graphically in one patient studied during the operative procedure. The preoperative examination was distinctly abnormal (DOT II) and during clamping of the internal carotid artery, the abnormality was magnified. All flow ceased during external carotid clamping and during common carotid clamping while the endarterectomy was being performed. Within minutes of total carotid occlusion, however, a distinct flow pattern returned in the supraorbital artery which suggested the presence of extensive collaterals, possibly from the other side of the neck. This patient showed an abnormal examination daily throughout his postoperative hospital course. He was restudied at one month after operation and the examination remained abnormal.

**Discussion**

The importance of non-invasive techniques in evaluating carotid artery disease is well established and they are particularly valuable for evaluating patients with asymptomatic bruits. Since a small percentage of patients undergoing carotid endarterectomy...
tomy develop recurrent stenoses during the first year from intimal hyperplasia, or later from recurrent atherosclerosis,15 it becomes highly desirable to follow patients without resorting to postoperative arch angiography. This study would seem to suggest that the use of the DOT alone is not adequate for postoperative evaluation since a significant number of patients fail to revert to normal following satisfactory endarterectomy. Since the DOT is dependent upon the development of collateral blood vessels between the internal and external carotid circulations, restoration of internal carotid artery flow to normal by endarterectomy may not necessarily lead to a regression of the collaterals in a predictable fashion. The persistence of collaterals between the external and internal carotid circulation, therefore, may lead to many false positive examinations in the postoperative period. The time course for the development and regression of collateral blood vessels is not well understood, but in a companion study we have observed that this might be a significant period.

A recent patient was studied during gradual occlusion of the internal carotid artery for treatment of a large, inoperable, intracranial carotid aneurysm. Once total occlusion occurred, flow fell in the ophthalmic system but no reversal was recorded. Three months following the operation, a large flow reversal was demonstrated during the DOT. The results reported in this paper are at variance with those of Moore, et al.16 who demonstrated that in the postoperative period the DOT was highly accurate in documenting reversal of abnormal patterns to normal supraorbital flow patterns. It is difficult to be certain why the results in this study are different, since the techniques used here were comparable to those reported by Moore.

The use of direct carotid ultrasonic auscultation and ultrasonic imaging in conjunction with the DOT has provided useful information in the postoperative period. Since these do not depend on collateral development, they are more highly accurate in assessing vessel patency postoperatively.

An alternative explanation for the abnormal examinations noted in this study would be the presence of continued disease in the carotid artery. This does not seem to be the case, however, since all patients with abnormal postoperative studies had normal images and no high frequency sounds during ultrasonic auscultation. In addition, operative angiograms taken at the time of operation demonstrated normally patent vessels without evidence of an intimal flap.

References

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Topical Prostacyclin (PGI₂) Inhibits Platelet Aggregation in Pial Venules of the Mouse

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SUMMARY  Local application of prostacyclin (PGI₂) to cerebral (pial) microvessels, inhibited the aggregation of platelets induced in the vessels by exposing them to a filtered mercury light source following intravenous sodium fluorescein. The inhibition was consistently observed in venules rather than arterioles and was manifest by a lengthening of the time required for the noxious stimulus to produce an initial aggregate, and/or by a lengthening of the time required for enlarging aggregates to totally block the venule. The consistency of the inhibition diminished at doses below 100 μg/ml. Inhibition was observed whether or not alcohol was used as the vehicle for PGI₂ and whether or not the body temperature of the anesthetized mouse was permitted to fall.

Methods

The method used has been reported previously. Male mice of the ICR strain (Dublin Farms) were anesthetized with urethane. Tracheotomy was performed, and about 35 minutes after the anesthetic was given a craniotomy was performed, the dura was stripped, and the surface vessels (pial vessels) were exposed. These vessels were studied at 110X magnification with a Leitz Ultropak lens system, one hr after anesthesia, and 25 min after craniotomy. After finding

Supported by USDHEW Grant HL-18932.

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Stroke. 1979;10:396-399
doi: 10.1161/01.STR.10.4.396

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