Hospital Topics

Cerebral function before and after carotid endarterectomy

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Summary

Twenty men had their cerebral function measured preoperatively and three months after carotid endarterectomy using the Halstead-Reitan neuropsychological test battery. Thirteen patients were cerebrally impaired preoperatively, but 12 of them improved appreciably after surgery. Changes in internal carotid arterial blood flow measured peroperatively showed no significant correlation with the improvement in neuropsychological status. We think that carotid endarterectomy carries an even better prophylaxis for the brain as a whole than had been thought.

Introduction

It is now more than 20 years since Eastcott's first reportedly successful operation for carotid artery disease and during this time operative procedures have become well established.¹ The usual site for atheroma in the neck is at the bifurcation of the common carotid artery extending into the internal carotid artery for one to two centimetres. Denny-Brown² suggested that a total reduction of cerebral blood flow—a haemodynamic crisis—caused the patient's symptoms, while Millikan and his colleagues³ felt that embolisation of mural thrombi from an ulcerated lesion was the main aetiological factor.

The classic syndrome of the stenosed internal carotid artery is the transient ischaemic attack (TIA). This presentation of unilateral carotid artery disease is one of ipsilateral visual disturbance (amaurosis fugax), contralateral hemiparesis, and contralateral hemianaesthesia, and, if the dominant hemisphere is involved, dysphasia. These symptoms may occur in isolation or in combination, and are repetitive but usually followed by neurological recovery. Patients with TIAs benefit most from carotid reconstruction and surgery is highly effective in preventing both recurrent attacks and subsequent major strokes.

In addition to the successful alleviation of symptoms, many patients have stated that their thinking has become clearer as a result of surgery. This factor was well shown by an accountant who was unable to work before his carotid endarterectomy, and within six weeks had returned to full employment.

We undertook this study to show objectively cerebral function before and after operation and also to relate these findings to changes in internal carotid arterial blood flow measured peroperatively.

Patients and methods

Twenty consecutive men with a mean age of 54.8 years ($\pm$ SD 6.45) were admitted for study before carotid endarterectomy. The duration

of symptoms varied from two years to one week and the frequency of symptoms from over six months to daily TIAs lasting up to 30 minutes. Seven patients had combinations of visual and limb symptoms and five had speech and limb attacks. Three patients had purely limb paralysis and one had attacks of amaurosis fugax alone. Three patients had combinations of speech, eye, and memory defects and one patient had attacks affecting his speech alone. Eight patients noticed a considerable deterioration in their memory, and three patients had residual neurological defects either with a persistent visual field defect or persistent speech defects.

Radiologically all patients had a demonstrable atheromatous plaque partially stenosing the origin of the internal carotid artery. Seven patients had their disease confined to one carotid artery, while five patients showed other diseases in the cerebral, neck, and arch vessels, which were not severe enough to influence surgery of the carotid bifurcation. No measurements of intraocular pressure were taken in the evaluation of the patients.

All patients were studied preoperatively and at three months after carotid endarterectomy, using the Halstead-Reitan battery of neuropsychological tests⁴ administered as standardised in Reitan's laboratory at the Indiana Medical Centre.⁵ The most important value is the impairment index, which is the composite score of all of the other tests.

To make the results clearer we used a T-score method, which allows representation of normality by the horizontal axis at the level of 50. This line represents the average normal value taken from a normal population for each of the indices; the higher the score the more impaired the patient.

Carotid endarterectomy was performed under general anaesthesia through a skin incision parallel to the anterior border of the sternomastoid muscle. After exposure of the carotid vessels the patient was heparinised (2500 units intravenously) and an internal polyvinyl shunt was used routinely. Internal carotid arterial blood flow was measured with an electromagnetic flow meter (Nycroton Blood Flowmeter 372, Nycroton, Oslo, Norway) before removal of the atheromatous plaque and after closure of the arteriotomy.

Results

Preoperative assessment—Preoperatively, the patients were appreciably impaired when contrasted with the normal population (fig 1).

FIG 1—Results of preoperative psychological tests. Horizontal axis represents normal population values. Imp = Impairment. Cat = Category. TPT = Tactile performance tests.

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The composite score or impairment index showed a clear difference ($P < 0.01$) and this impairment was reflected in most of the tests, there being a highly significant difference in the category test ($P < 0.001$) and in the tactile performance test for time ($P < 0.001$) and location ($P < 0.001$). In the rhythm test our patients scored at a better level than the normal controls ($P < 0.05$). This was an unexpected finding which, if replicated, will deserve further investigation because of its theoretical implications.

Postoperative assessment—Fig 2 shows the improvement in the results of postoperative testing. In some areas the patients still showed degrees of cerebral dysfunction in that the trails B test ($P < 0.05$) and tactile performance test for time ($P < 0.02$) and location ($P < 0.01$) showed impairment, but overall there was a significant improvement as judged by the fact that the impairment index showed no difference when contrasted with the normal population.

FIG 2—Results of postoperative psychological tests. See legend to fig 1 for key.

Comparison of pre- and postoperative assessment—Fig 3 shows the results contrasting assessments before and after operation. There was a significant overall improvement as judged by the impairment index ($P < 0.02$). This improvement was shown most clearly in the category test ($P < 0.01$) and the time component of the tactile performance test ($P < 0.001$).

Measurement of peroperative internal carotid arterial blood flow—The mean blood flow in the internal carotid artery in 16 patients was 98 ml/min (SE of mean ± 21) before removal of the atheromatous plaque and 232 ml/min (SE of mean ± 27) after closure of the arteriotomy. Eleven of the 16 patients increased their blood flows by more than half and there was a significant difference between the values before and after operation ($t = 3.97$; $P < 0.01$). The internal carotid arterial blood flow was not measured in four patients because of unsuitability of the electromagnetic flow meter probe during the operative procedure.

Correlation of change in impairment index with changes in internal carotid arterial blood flow—There was no significant correlation between change in impairment index and change in internal carotid arterial blood flow ($r = 0.06$).

FIG 3—Comparison of pre- and postoperative tests. See legend to fig 1 for key.

Discussion

This study has confirmed objectively the clinical impression that carotid endarterectomy greatly improves cerebral function. Goldstein *et al*⁵ studied six patients in a similar manner, and analysis of their results showed improved performances in all the tests. Horne and Royle⁶ investigated 16 patients using the Wechsler adult intelligence scale, the Wechsler memory scale, and the Benton visual retention test. Significant improvement was noted in the object assembly subtest and full-scale intelligence quotient test in the Wechsler adult intelligence scale.

Carotid endarterectomy has been developed as a prophylactic procedure to remove the source of emboli formation within an atheromatous plaque. In addition to the apparent prophylactic nature of the operation we have reported a significant increase in blood flow in the internal carotid artery after endarterectomy, though measurement of flow in a single arterial supply of the circle of Willis may not be representative of total cerebral blood flow. This increased blood flow, however, is not significantly related to the changes shown in neuropsychological testing. There may be two explanations for this apparent discrepancy. Firstly, a minimal blood flow might be required for normal cerebral function and this is restored by removal of the atheromatous plaque. Secondly, the formation and embolisation of thrombi might be a much more dynamic process, resulting in a continuous showering of emboli into the cerebral circulation impeding blood flow for intellectual as well as motor and sensory function. If this is so, then carotid endarterectomy carries an even better prophylaxis for the brain as a whole than was previously realised.

References

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Is poor memory common in young epileptics?

Poor memory is not a feature of epilepsy in young epileptics. But it may be one of the undesired side effects of taking barbiturates or primidone. If this side effect is important, it would be worth while trying other anticonvulsant drugs. Barbiturates are one of the last drugs to try as they have more side effects, particularly on intellectual functions, than the other drugs.

What on-the-spot resuscitative measures are reasonable for a doctor to take when an apparently healthy 60-year-old man has "died" suddenly?

A quick examination should be made for signs of injury or inhalation of a foreign body, false teeth removed, and a clear airway ensured. If possible the patient should be laid flat on a hard surface. A sharp blow at the lower end of the sternum may start the heart beating, but, if not, regular external cardiac massage should be started with the hands placed one on top of the other over the lower end of the sternum. It is important to confine pressure to the sternum so as to avoid damaging the ribs. Compression should be carried out at a rate of at least 60/min and mouth-to-mouth or mouth-to-nose respiration about every six compressions. An assistant is helpful, and someone should be instructed to call an ambulance. Resuscitation should be continued for at least 10 minutes, watching for return of the pulse and constriction of the pupils. If adrenaline is available, 0.3 mg 1:1000 solution may be injected into the heart.