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COGNITIVE CHANGES AFTER CAROTID ENDARTERECTOMY

Sixteen patients undergoing carotid endarterectomy operations were tested before and after undergoing operation on a series of standardized cognitive tests. The results from this limited pilot study showed no postoperative deterioration in level of cognitive function, and some aspects actually improved significantly.

Patients with more severe degrees of arterial obstruction were older and generally were found to have a lower level of cognitive ability. However, their response to operation was as good as that of the patients with milder impairement.

In 1954, Eastcott et alii reported the reconstruction of the internal carotic artery in a patient with intermittent attacks of hemiplegia, and since that time the operation of carotid endarterectomy has become a firmly established procedure. The most common site of stenosis is the proximal one to two centimetres of the internal carotid artery. Adams et alii (1963) showed that there was a significant reduction in cerebral blood flow in patients severely incapacitated by attacks of cerebral ischemia, and removal of the stenotic lesion restored cerebral blood flow to normal. The stenotic lesion may ulcerate and provide a source of cerebral emboli (Julian et alii, 1963). Whether the transient cerebral ischemic attacks were due to emboli or to alterations in cerebral hemodynamics, the operation as practised has been regarded as a prophylactic procedure, to protect against further transient ischemic attacks and against a future major catastrophic stroke.

The technique of operation was constant throughout the study. All operations were carried out under general anesthesia with continuous monitoring of the systemic blood pressure. An internal polyvinyl shunt was used routinely; this allowed a total occlusion time of two to three minutes before insertion of the shunt, and once again two to three minutes on withdrawal. No occlusion time exceeded five minutes. The operative technique was routinely checked by immediate postoperative angiography.

No patient in the series suffered any demonstrable neurological defect as a result of the operation. However, it was possible that during the manipulation of the artery, small thrombi might have been set free and the anesthesia and temporary hypoxia might have caused more subtle intellectual impairment. The first object of the study was to determine whether any significant decrement in cognitive ability occurred as a result of the operation.

Before commencement of this study there were two patients who appeared to show a marked mental improvement after the operation. The first patient was a 60-year-old Russian who spoke no English. Following bilateral carotid endarterectomy, his mental improvement, as judged by his relatives, was very marked indeed. The second patient was a 45-year-old woman from a mental hospital. She had a transient ischemic attack, following which a bruit was heard in the neck. Angiography revealed a complete occlusion of the left internal carotid artery, stenosis of the right internal carotid artery, and stenosis of the right vertebral artery. After right carotid endarterectomy she made a marked mental improvement and could be moved to a less supervised ward in the mental hospital. The possibility of her eventual discharge is now being considered.

The second object of the study was to see whether a battery of carefully conducted intellectual tests would demonstrate improvements in cognitive function in a manner which could be documented.

METHODS

Patients selected for this study were those without any neurological deficit from a recent transient ischemic attack or patients with a stable deficit as a result of a minor stroke which was not recent. Sixteen patients were tested in the week immediately preceding operation. Two women had no postoperative tests at all. (One had a coronary attack two days after the carotid endarterectomy on her second side and died three months later. The other was unwilling to undergo postoperative testing because of the death of her husband.) Early in the study the complete form of the battery of tests had not been determined and some patients did not have a complete set of tests performed. In addition, there was a range of postoperative assessment times.

The three tests used were the following:

1. A short form of the Wechsler Adult Intelligence Scale (WAIS) (Wechsler, 1955). This is a test of both verbal and performance intelligence. The comprehension, similarities, digit span and vocabulary subtest of the verbal scale were used and the block design and object assembly subtest of the performance scale were used. Analysis of the results was made on the individual subtest

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scale scores and on the prorated verbal and performance intelligence quotients (IQs).

2. The Wechsler Memory Scale (WMS; Wechsler and Stone, 1945). This test was used to challenge general memory function. Seven subtests (personal and current information, orientation, mental control, logical memory, digit span, visual reproduction, associate learning) were used, from which an overall memory quotient (MQ) analogous to the IQ could be obtained. Analyses of the results of scores in the subtests and the MQ were available for study. In order to minimize practice and familiarity effects, Form 1 was administered before the operation and Form 2 after the operation.

3. The Benton Visual Retention Test (Benton, 1963). This test specifically measures short-term visual memory and is designed to be a screening test for detecting "acquired intellectual impairment". Actual performances were compared with expected performance on the basis of age and intelligence. Once again, in order to avoid practice and familiarization effects, Form C was given before the operation and Form D after the operation.

RESULTS

Although improvement in cognitive function appeared to take place in five out of the six WAIS subtests, and in the two prorated IQs, there were only two results which were statistically significant. The performance on the object assembly subtest of the WAIS based on results from twelve subjects showed improvement from 56 to 70 (P < 0.005) and the WAIS performance scale IQ showed improvement from 94.7 to 101.1 (P < 0.001) (Table 1).

|          | Before Operation | After Operation |
|----------|------------------|-----------------|
| WAIS Performance Scale IQ | Mean | SD | Mean | SD |
|          | 94.7            | 11.7            | 101.1          | 11.3 |
|          | 11.7            | 11.3            |
| WAIS Object Assembly Subtest Scaled Score | Mean | SD | Mean | SD |
|          | 5.6             | 2.0             | 7.0            | 2.5 |
|          | 2.0             | 2.5             |

In the WMS there were five subtests on which subjects performed better after the operation than before the operation and two which showed poorer performance. Neither these nor the MQ changes were statistically significant. Before the operation the MQ was 99.7 (SD = 21.3) and after the operation it was 101.3 (SD = 19.5).

On the Benton Test there was a slight postoperative deterioration in the level of performance, but this was not statistically significant. Those patients with impairment of performance on the Benton Test were tested a third time three months later and all but one of the patients had returned to a preoperative level. The numbers involved are too small for statistical analysis, but this is to be investigated further.

A further analysis was carried out by classifying patients into severe and mild cases on the basis of angiographic evidence of the severity of atheroma. Only those with complete angiographic assessment of all vessels were included in this analysis. There were six severe cases with a mean age of 50.4 years and five mild cases with a mean age of 64.4 years. From analysis of variances for all scores, considering scores on tests administered before and after operation and the severity of atheroma, the only significant differences to emerge were for the block design subtest of the W AIS and the visual reproduction subtest of the WMS. In both these tests there was either a postoperative improvement in score or no change for both groups, but the mild group had better scores throughout than the severe group. What is more, the severity of impairment did not prevent improvement in scores on tests administered after the operation.

DISCUSSION

In this pilot study no test or subtest showed a significant decrease in the level of cognitive function after the operation of carotid endarterectomy. On the contrary, some aspects of performance intelligence were found to improve significantly.

There were some individual differences which were more marked, the greatest being an increase in verbal IQ from 54 to 91. In one patient the verbal IQ fell by 11 points after the operation. The falls which occurred with the Benton short-term memory test seemed to be a temporary impairment which later resolved. These individual considerations will be followed up with further study.

As expected, the degree of atheroma of the extracranial circulation was correlated with age. The more severe cases tended to have a lower level of cognitive functioning than the milder cases both before and after the operation. However, severity of stenosis did not prevent postoperative improvement occurring in some aspects of cognitive function.

The question of laterality of stenosis at operation was also considered, but the results were insufficient for this to be helpful. It will certainly be investigated in the future.

This pilot study has indicated that a further study with control subjects and a more rigorous experimental design may provide interesting information on the mental effect of the operation of carotid endarterectomy.

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