

A 5-year review of carotid endarterectomy in a vascular unit using a computerised audit system

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BIPAS, a computerised vascular audit has been used to analyse the results of 203 carotid endarterectomies performed over a 5-year period in a vascular unit. In addition, all but two patients have been followed up with regular duplex scans. The indications and surgical techniques have remained similar over the study period though preoperative carotid arteriography is no longer considered essential and intraoperative monitoring with transcranial Doppler insonation is becoming routine.

There were six perioperative deaths and 20 postoperative neurological defects. However, only three survivors had any long-term disability. It was not possible to identify any particular patients at high risk of perioperative stroke, although simultaneous major surgery and significant bilateral carotid endarterectomy seemed to be more hazardous.

Routine follow-up using duplex scanning identified patients with late occlusion (5%) and restenosis (8%), but only three patients (1.5%) suffered a late stroke.

Once the perioperative hazards of death and permanent stroke (4.4% in this series) have been overcome, carotid endarterectomy provides good protection against subsequent stroke.

Carotid endarterectomy is a prophylactic operation to prevent stroke and as such it should carry a low morbidity and mortality. Aspirin has been used in the treatment of carotid artery disease, but the evidence for its efficacy did not include randomisation with carotid endarterectomy (1-3).

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There is now strong evidence that surgery provides better protection against stroke than aspirin in patients with symptomatic carotid artery stenosis of >70%. A clinical alert from the North American Symptomatic Carotid Endarterectomy Trial indicated this trend and was subsequently followed by the results of the European Carotid Surgery Trial (4,5). The latter is a large, multi-centre study involving 2518 patients. There were 778 patients with 70-99% carotid stenosis, 458 were randomised to surgery, of these 7.5% suffered a stroke or died in the first 30 days, 5% in the control group. In the next 3 years only another 2.8% had a stroke compared with 16.8% of controls ($P < 0.0001$). This reflects the results of previous uncontrolled trials of surgery and of aspirin (6).

The results of carotid endarterectomy in Bristol over a 5-year period have been reviewed using a computerised vascular audit system. Follow-up data has been added to this information. The aim of this audit was to ensure that the highest clinical standards are maintained and to monitor any changes in practice. An attempt was made to identify patients at high risk of developing a perioperative stroke.

Patients and methods

Since September 1984 records of all vascular procedures have been kept on a computerised audit system BIPAS (Bristol Infirmary Patient Audit System). Patients' details, indications for treatment and operative procedure are entered into a computer kept in the operating

theatre at the time of their surgery. Any postoperative complications are logged into the computer at hospital discharge and verified at the monthly vascular audit meeting attended by all vascular unit staff. A computer-derived inpatient record is available for general practitioners.

Prospectively collected information on all patients who underwent carotid endarterectomy from 1985 to 1989 has been reviewed. In addition, clinical follow-up and carotid duplex ultrasound scan results at 6 weeks, 6 months, 1 year and then annually were available for all but two patients.

In this period 203 carotid endarterectomies were performed on 191 patients under the care of two consultant surgeons. There were 66 females and 137 males. Ages ranged from 31 to 84 years; median 65 years. None had synchronous procedures and therefore analysis is related to procedures rather than patients. Postoperative neurological defects were classified in the same way as Browse and Ross-Russell (7):

- (a) *Transient ischaemic attacks*. Episodes of local cerebral sensory or motor disturbance lasting less than 24 h.
- (b) *Clinically recovered defects*. Sensory or motor defects which lasted for more than 24 h but had fully recovered clinically by 2 months.
- (c) *Clinically permanent defects*. Patients whose motor or sensory symptoms were still present 2 months after the operation.

Preoperative assessment

All patients were investigated with duplex ultrasound scanning. Carotid arteriography was performed on every patient in the first 3 years of the study; but recently some patients had operations on the basis of the duplex scan alone, arteriography being reserved for a mismatch between the scan result and the clinical picture or when the duplex report suggested occlusion or subocclusion (8).

Indications for surgery

Amaurosis fugax and transient ischaemic attacks (TIA) accounted for the indication in 173 (85%) patients. Carotid endarterectomy was performed in 18 (9%) patients with full recovery after a recent stroke.

Eight patients (4%) were asymptomatic. Four were selected prior to cardiac or major vascular surgery because routine examination revealed a carotid bruit and significant internal carotid artery stenosis (>50%) was then discovered. In four cases bilateral carotid disease was treated by endarterectomy of the symptomatic side followed by endarterectomy of the contralateral side because of a critical stenosis (>70%).

A further 2% of cases had global symptoms, including dizziness, memory disturbance and other non-focal neurological symptoms.

Operative technique

All patients had operations under general anaesthesia, and a Javid shunt was used routinely. No special anaesthetic techniques were employed, but a higher than normal blood pressure was maintained if possible. All patients received heparin before clamping which was not usually reversed at the end of the procedure.

Various methods of intraoperative monitoring have been employed, including the hand-held Doppler, Doppler flow meter and transcranial insonation of middle cerebral artery blood flow.

A vein patch repair was used on 11 occasions when the internal carotid artery was small.

Results

Of 203 carotid endarterectomies, six patients (3%) died during the perioperative period (two from stroke), and a further 18 patients had cerebral neurological complications (Table I).

Two deaths were associated with simultaneous major surgery. One myocardial infarction followed bleeding in the groin after an aortobifemoral graft and one patient who had simultaneous coronary artery bypass grafting could not be weaned off cardiac bypass.

All but six patients with cerebral neurological defects had fully recovered by the first outpatient review, only three suffered long-term disability.

Preoperative details and surgical indications were analysed to try to identify groups at high risk of perioperative neurological complications. No significant factors were identified from age, sex, indication for surgery, urgency of surgery or severity of carotid stenosis. However, seven of the 20 deficits occurred in the 12 patients who had sequential bilateral carotid endarterectomy, although three occurred at the time of the second operation.

Four patients who developed hemiplegia in the early postoperative period had urgent reoperation. In three

Table I. Morbidity and mortality

<i>Neurological defects</i>	
Fatal stroke	2 (1%)
Permanent defect	3 (1.5%)
Clinically recovered defects	12 (6%)
Transient ischaemic attacks	3 (1.5%)
<i>Other deaths</i>	
Myocardial infarction	3 (1.5%)
Post-coronary artery bypass	1 (0.5%)
<i>Cranial nerve palsy</i>	
Hypoglossal	12 (6%)
Facial	7 (3.5%)
<i>Minor complications</i>	
Haematoma	2 (1%)
Retention of urine	2 (1%)
Chest infection	2 (1%)

Table II. Results of clinical and duplex follow-up

Early occlusion (<6 weeks)	4 (2%)
Late occlusion (>6 weeks)	6 (3%)
Restenosis (>50%)	16 (8%)
Late stroke	2 (1%)
Late death	20 (10%)

cases thrombectomy was performed, a vein patch being used in one. In the other case the internal carotid artery was found to be patent and no further action was taken. Two of these strokes were permanent, others resolved in 1–3 weeks.

The incidence of cranial nerve palsy was high; 19 patients (10%) were affected. In most cases the hypoglossal nerve was affected but a few developed partial facial nerve palsy due to bruising of the mandibular branch. A full recovery was observed in all patients.

Follow-up

Complete follow-up was available for all but two patients for between 12 and 78 months; median 42 months (Table II).

Only one of the 10 late occlusions resulted in a stroke. This patient had recurrent TIAs and arteriography revealed a patent proximal internal carotid artery with a kinked distal loop. The patient suffered a stroke 1 year after carotid endarterectomy. One of the 16 patients (8%) who developed a restenosis developed further TIAs which resolved after successful percutaneous transluminal angioplasty. Eight other patients reported various non-specific symptoms which might have been TIAs, but none had restenosis and none progressed to stroke.

Of the 20 late deaths only two were due to stroke; one at 1 year due to a contralateral cerebral infarction and one at 6 years due to cerebral haemorrhage, both proved at autopsy.

Discussion

Carotid endarterectomy does have the serious complications of death or disabling stroke, but the risk is no greater than that of 1 year of untreated disease (7,9). A successful carotid endarterectomy can abolish disabling neurological symptoms and provide excellent protection against late stroke. It is the treatment of choice for symptomatic carotid artery stenosis of >70% (4,5).

This series was examined through our vascular surgical audit system. The use of audit to ensure acceptable clinical standards is now appreciated (10). Audit also allows more accurate planning for the future and can suggest targets for resources (11,12). Changes in practice may be instituted and evaluated by audit, the major change in this series is a decrease in the number of patients having carotid arteriography before carotid endarterectomy. One side-effect of surgical audit is that

complications are actively sought and are therefore higher than implied by retrospective analysis.

It has been suggested that complications of endarterectomy are related to the indication for surgery, being higher for stroke than for TIA (13–15). No clear 'high risk' patients could be identified from this series, although patients with severe disease requiring bilateral carotid endarterectomy seemed to be at extra risk of neurological defects. The numbers are small, but two of the six deaths occurred in patients having simultaneous major surgery. Others have, however, described this as safe (16,17).

Comprehensive follow-up using duplex scanning has provided useful natural history data after surgery. Although occlusion and recurrent stenosis are not infrequently identified, late stroke (two cases, 1.5%) was rare. Recurrent stenosis (8%) seemed to be less likely to produce symptoms and might be less dangerous than originally thought (18). It is too early to assess the value of follow-up duplex scanning and 10-year results in Bristol are awaited, but routine follow-up of these patients may be unnecessary. This study of carotid endarterectomy has shown that a computerised audit system can provide accurate and detailed information for analysis. Although a perioperative death and disabling stroke rate of 4.4% is not grounds for complacency it is similar to that reported by others (13,15,19–21).

However, this audit has failed to identify high-risk groups to target for improvement and therefore completion of the feedback loop to improve results is unlikely (22). Long-term follow-up of these patients has shown that once the perioperative complications have been overcome, carotid endarterectomy provides a good protection against stroke.

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Invited comment

The Bristol Group should be congratulated on this detailed report based on careful audit with a 99% follow-up of between 12 and 78 months. As distinct from other reports of very large numbers of operations performed by individual virtuosi with less than 3% mortality/neurological morbidity rates, this report comes from a teaching centre committed to not only providing a comprehensive vascular service, but also to the training of senior registrars in this procedure. Despite this, the perioperative mortality/permanent stroke rate is commendably low at 4.4%. The procedure shares a high myocardial mortality rate (1.5%) with other vascular operations, and one-third of all neurological complications occurred in bilateral procedures, with approximately one half complicating the first side and the other half the second side. However, only four of a possible 20 arteries were re-explored after a neurological event, and

it is important to develop a policy based on audit to deal with this unfortunate outcome. The use of vein patching in one re-exploration, together with the reported occlusion and restenosis rates, must raise the question of whether or not routine patching of the internal carotid should be employed. The routine use of shunting allows the teaching of senior registrars to take place in an unhurried atmosphere, and removes altogether the need for intraoperative cerebral monitoring, which is essential when a policy of selective shunting is employed. Above all, the report demonstrates well the great merit of detailed audit of procedures as well as their outcome.

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