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Carotid Endarterectomy in the U.K. and Ireland: Audit of 30-day Outcome

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Objectives and Design: *A prospective study of 709 patients undergoing carotid surgery in the U.K. and Ireland was performed to evaluate the performance of vascular surgeons.*
Materials and Methods: *Fifty-nine surgeons (range 2–39 cases each) were sampled and all patients undergoing surgery over a 6-month period (1 March 1994–31 August 1994) were included in the study. Indications for surgery were TIA (35.9%), AF (23.3%), CVA (21.4%) and "others" (19.6%).*
Results: *Mean ipsilateral stenosis was 82% (30%–99%). Thirty-one percent of patients had preoperative neurological consults. Shunts were used in 67.6%, tacking sutures in 40.1%, drains in 71.9% and patches in 54.4% of cases. At 30 days there were nine (1.3%) deaths (four cardiac, three neurological). There were 15 ipsilateral postoperative CVAs (2.1%); 19% of patients had one or more complication, usually minor. Statistical analysis showed no independent risk factor for CVA other than seniority of the surgeon.*
Conclusions: *A combined stroke/death rate of 3% for the series was obtained at 30 days for all cases. This large, validated study suggests that members of the Vascular Society of G.B. and Ireland currently have a very low morbidity/mortality rate for performing carotid surgery. Continued audit is required to ensure that this quality of service does not deteriorate.*

Key Words: Carotid endarterectomy; Outcome; Vascular surgery.

Introduction

Carotid endarterectomy has enjoyed increasing acceptance over the past 4 years, largely due to the publication of results from both the MRC European Carotid Surgery Trial and the North American Symptomatic Carotid Endarterectomy Trial.[1–3] Both of these studies showed that in the presence of ipsilateral symptoms and a carotid artery stenosis of >70%, carotid endarterectomy confers a definite advantage in terms of reduced stroke risk to patients who are otherwise medically fit. As a result of these studies, it might be expected that carotid surgery would once again become a common operation and that operation numbers would rise to levels seen in the early eighties.[4]

The Vascular Surgical Society of Great Britain and Ireland (VSS) was concerned that such an inevitable increase in the number of operations performed might result in outcomes that were poorer than those found in the major international studies, particularly bearing in mind that those centres selected for these studies were required to have demonstrated a reasonable past track record for the operation. The VSS council therefore mandated their audit committee to examine the performance of members of the society with a prospective study in a randomly sampled group of members known to be performing carotid surgery.

The aims of this audit were: (i) to establish the current stroke and mortality rate for the VSS and thus provide a local standard against which members could compare their own data; (ii) to examine the indications investigations and currently favoured operative practices used by members of the society.

Methods

This prospective study of carotid endarterectomy examined the demographic data and 30-day outcome in all patients undergoing surgery under 59 consultant surgeons. Initially, 60 members of the VSS were randomly selected to participate in the study. A cross-section of surgeons was taken to include university centres, district general hospitals, full-time vascular surgeons and general surgeons with a vascular interest. Of the initial requests for participation, six surgeons

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did not reply and a further group was recruited in order to obtain at least 500 cases for the period of interest. Participants in the present study represented approximately 50% of consultant vascular and general surgeons who were known to currently perform carotid surgery in the VSS. Participation was entirely voluntary and surgeons were asked to include all patients having carotid endarterectomy within a 6-month period from 1 March 1994–31 August 1994.

A single-sided A4 questionnaire was completed for each patient who underwent surgery. Twenty-eight questions were asked, and the main end-points were death and postoperative stroke at 30 days. No patient-identifiable data were recorded, although the centre number was recorded initially until data verification was complete. Data were returned to the VSS office and entered into a customised database (DataEase, Sapphire Solutions, U.K.). After preliminary analysis, further specific requests were made for missing information and for details of patients where there appeared to be conflicting information. To validate the study, 122 cases were sampled and examined by an independent non-surgical observer who visited the hospitals concerned and went through the patients' records to look for discrepancies, to verify the primary end-points and to check that all carotid endarterectomies for the period had been entered into the study. Statistical analysis was performed with Chi-squared tests and non-parametric analysis where relevant.

A further effort to validate the data was made by carrying out an audit of the data sample and of data centres. Two independent observers (physicians) retrospectively reviewed the notes of 122 cases (17.5% of the series) and looked for any discrepancies in data entry and specifically for any anomalies in reported outcome. In addition, the centres sampled were checked to ensure that all carotid endarterectomies for the period had indeed been included in the study.

Results

Data were returned on 709 patients by 59 surgeons. Following validation, 12 cases were rejected, leaving 697 cases available for detailed analysis. Those rejected included three duplicate cases. Of the remainder, none of the nine cases (with incomplete data) had a postoperative CVA or postoperative death. Mean patient age was 66.8 (range 34–89) years. One hundred and twelve operations were performed in patients aged 76 years or more. Hypertension was present in 53.3%, symptomatic ischaemic heart disease in 46.6%, diabetes in 15.9% and arrhythmias in 6.1%.

Table 1. Indications for surgery.

Ipsilateral TIA	251 (35.9%)
Amaurosis fugax/retinal artery occlusion	163 (23.3%)
Ipsilateral CVA	150 (21.4%)
Asymptomatic stenosis	57 (8.1%)
Contralateral symptoms	62 (8.9%)
Vertebro-basilar symptoms	17 (2.4%)

Table 2. Source of referral.

Consultant physician	266 (38.0%)
General practitioner	200 (28.6%)
Neurologist	128 (18.3%)
Other surgeon	48 (6.9%)
Ophthalmologist	35 (5.0%)
Other	10 (1.4%)

Table 3. Preoperative assessment procedures.

Duplex scan	674 (96.4%)
Arteriogram	384 (54.9%)
CT scan	264 (37.7%)
Transcranial Doppler	138 (19.7%)
MRI scan	98 (14.0%)
Occuloplethysmography	18 (2.6%)
Neurology consultation	220 (31.4%)

Table 4. Operative details.

Mean operative time	96.1 min (30–240)
Mean carotid occlusion time	13.1 min (1–85)
Shunt	473 (67.6%)
Tacking	281 (40.1%)
Drains	503 (71.9%)
Patches	317 (45.6%)

Indications for surgery are shown in Table 1 and referral patterns in Table 2. Mean ipsilateral percentage stenosis was 82% (30–99%). Mean contralateral percentage stenosis was 53% (0–100%). Preoperative assessment details are shown in Table 3. Interestingly, 316 (45.1%) of patients did not have a preoperative angiogram. Mean time from initial referral to review in clinic was 16.1 weeks (1–260), while mean time from clinic to operation was 10.8 weeks (1–231).

Eighty percent of procedures were performed by a consultant (as first surgeon); only 135 cases were carried out by a trainee. Operative details are shown in Table 4. Patches were used in 46% of cases; Dacron 160 (23%), vein 89 (13%) and PTFE 49 (7%). Peroperative

Table 5. Peroperative monitoring.

No monitoring	236 (33.7%)
Transcranial Doppler	236 (33.7%)
(Stump pressures)	146 (20.9%)
EEG	46 (6.6%)
Local anaesthesia	18 (2.6%)
Other	8 (1.1%)

Table 6. Postoperative completion assessment.

Nil	68 (9.7%)
Palpation	387 (56.7%)
CW Doppler	108 (15.4%)
Duplex	39 (5.6%)
Angioscopy	41 (5.9%)
Angiography	6 (0.9%)

Table 7. Complications following carotid surgery.

Ipsilateral CVA	15 (2.1%)
Ipsilateral TIA	16 (2.3%)
Contralateral symptoms	11 (1.6%)
Death	9 (1.3%)
Haematoma	32 (4.6%)
Neuropraxia	30 (4.3%)
Cardiovascular	15 (2.1%)
Patch blowout	1 (0.2%)
Other complication	40 (5.7%)
Total cases with complication(s)	134 (19.1%)

Table 8. Increased risk of postoperative CVA with trainee.

	Trainee	Consultant	
Postoperative CVA	7	8	15
Full recovery	128	557	685
	135	665	
	$\chi^2=5.69$;	$p<0.02$	

monitoring parameters are shown in Table 5 and postoperative completion assessments shown in Table 6.

Mean hospital stay was 7.1 days (1–91). Postoperative recovery monitoring was performed in: ICU 17.4%, HDU 36.3% and ward 44.7%. Complications are detailed in Table 7.

Subanalysis was performed on a number of subgroups which have traditionally been regarded as having an increased risk of stroke. Contralateral occlusions showed no significant increase in risk ($\chi^2=0.73$; $p=$n.s.). Likewise, age, use of a shunt, patching, and length of time of surgery all failed to correlate with a significant increase or decrease in operative risk. A smaller number of carotid operations carried out by each surgeon did not increase stroke risk; similarly, there was no apparent increase in risk where carotid surgery was performed in district general hospitals rather than university hospitals. The only independent risk factor which conveyed an increased risk of stroke was the presence of a trainee as the first surgeon (Table 8). Unfortunately, it is not clear from the present data what percentage of the trainees were supervised.

Discussion

Murie and others[4–6] have documented the trends in carotid surgery within Great Britain and Ireland over the past decade and have recently highlighted the increase in carotid operations since 1991. The present study suggests that their estimate is probably correct, because when we extrapolate the present data (which is representative of about half of practising carotid surgeons over a 6-month period) by multiplying by four times, we find that the resultant approximation of 2800 for 1994 is probably consistent with the 2628 found for 1992 in Murie's data. Such an increase is only good medical practice if it can be demonstrated that the outcome is consistent with currently accepted standards of intervention. The initial results of the present audit are therefore reassuring, in that they demonstrate no apparent deterioration in performance when compared to the two definitive studies in this area.

A combined stroke and death rate of 3% for the series is highly satisfactory and compares very favourably with the results of both the European and North American trials. This is especially important because the present study looked at a large sample of all types of general and vascular surgeons who performed carotid surgery and the results contrast with data from reported "community" series where higher, though variable, stroke/death rates have been reported (5.6%–21%).[7–11] There may be several reasons why this is so. Firstly, the antipathy of physicians to carotid surgery in the eighties combined with more exacting outcome analysis has probably made some surgeons who are not wholly comfortable with the operation abandon it. Secondly, peer pressure from anaesthetic and other colleagues is more prevalent, and ensures that each surgeon in the U.K. is likely to be made uncomfortably aware of his/her shortcomings in the face of consistently poor outcomes. Thirdly, the indications and preoperative assessment for carotid endarterectomy have become much more precise, so that the operation is much less likely to be carried out for inappropriate reasons. Despite this, the present data show that 11.3% of cases were performed for indications that would be regarded as "unproven" on the basis of current medical evidence.[12] A further 8% of cases were asymptomatic, but most of these were carried out as part of the European Asymptomatic Carotid Trial.

Great care must be taken when attempting to judge the ability of colleagues on the basis of any small series of personal cases, and this is particularly so with carotid surgery. Audit of outcome must therefore be performed over a reasonable period before meaningful conclusions can be drawn. On the other hand, surgeons who persistently show poor results should probably be discouraged from continuing to perform carotid surgery, as nowhere is the division between success and failure so fine and critical.

There are several areas in which the present study may be potentially criticised. Although prospective, the study was not controlled in the sense that we could not be absolutely certain that every surgeon had entered all his patients for the period and in particular had entered all patients with significant complications. However, all studies, including randomised controlled trials, rely upon honesty. For example, if a number of adverse events are not reported in the current European Asymptomatic Carotid Artery study, then a false impression of the efficacy of surgery may be obtained. Hence, the value of all studies is to some extent subject to the diligence and honesty of the participants, and the present study is no exception.

Secondly, the principal and most important postoperative complication was ipsilateral stroke. Whilst definition of a stroke should not be an issue (in the present study it was taken to mean all strokes, major and minor), it is possible that some participants may have "missed" the occasional stroke. The design of the questionnaire was therefore set to check on this by also enquiring about status at 30 days. Where an apparent discrepancy was uncovered, further details about the patient were requested. In this way it is likely that most, if not all, relevant postoperative strokes were documented. The study itself was designed to examine current practice and the absence of a neurologist in the majority of cases is factual; however, it must be said that neurologists in themselves do not have any special "gift" to diagnose internal carotid CVAs. Any vascular surgeon who wishes to perform carotid surgery ought to be able to select patients for surgery on the basis of current criteria and diagnose hemispheric CVAs.

Thirdly, the study was a sample, and although it represented about 50% of active carotid surgeons, it was voluntary. It is possible that those surgeons who did not respond to the initial request to participate may not have achieved similar results, although there is no objective reason why this should be so.

Apart from showing a very acceptable major morbidity and mortality rate, the present study has exposed a number of interesting points with regard to carotid surgery as currently performed in the U.K. and Ireland. There is a surprisingly high minor complication rate (Table 7). While most of these complications are inconsequential and do not seem to have significantly increased mean hospital stay, they do suggest that more care and attention should be given to areas such as prevention of postoperative haematoma and neuropraxias. Interestingly, the risk of patch blow-out was 1:89 in the present series, although we do not know where surgeons harvested their vein from.[13,14]

One major criticism of practice in the present study must be the exceptionally long lead times to clinical review, and subsequently surgery. Although subanalysis shows that a relatively small number of surgeons had disproportionately long delays to surgery, which somewhat skewed these data, these were mostly surgeons who had the largest practices. It would thus seem that there may be a "trade-off" of high volume caseload against time to surgery, which is perhaps unsurprising but is presumably due to resource constraints. Much more worrying is the delay in referral patterns, which is clearly an area which requires more attention. Subanalysis of this area showed no specific trend, suggesting that either physicians, neurologists and others are slow to refer patients or that vascular surgeons are not "fast-tracking" their carotid patients. In addition, there was no evidence that this delay prejudiced the individual patients in this study, although it is conceivable that there may have been other patients who had a stroke while awaiting review and thus were never entered into this study. Whilst these are certainly areas requiring improvement in clinical standards, they do not in themselves detract from the results of surgery in this series as such.

The risk of surgery in carotid stenosis with contralateral internal carotid occlusion has been a controversial issue. Recent data from the NASCET Study suggests an increased perioperative stroke risk of up to 14%. However, several studies have suggested that this is rather high. A recent paper by Cao *et al.* showed no significant difference between surgery in 55 patients with contralateral occlusion and 110 patients with patent contralateral arteries.[15] In the present study, 108 operations were performed in patients with contralateral internal carotid occlusion. At 30 days there were three strokes and two postoperative deaths. Although this is a slightly higher combined stroke/death rate (5.6%) than overall, it fails to reach statistical significance ($\chi^2 = 0.73$; p = n.s.). As these patients carry the greatest risk of stroke when treated medically (56% at 2 years in the NASCET study), this small increase in risk is more than offset by the potential benefits of surgery.

The one statistically significant risk factor for stroke was the presence of a trainee, either senior registrar (126 cases) or registrar. Why this should be so is unclear, as presumably most cases, if not all, should have been supervised by the consultant directly. However, if this finding is real, it has important implications in the training of our future vascular surgeons.

One hundred and twelve cases were carried out on patients aged 76 or greater. The combined stroke/death risk was 1.8%, which is less than the series as a whole, though not significant ($\chi^2 = 0.27$). This probably reflects good case selection on the part of participants and demonstrates that age alone is not a barrier to successful carotid endarterectomy. As stroke risk is known to increase with age, these patients may paradoxically derive the most benefit from surgery.

Perioperative monitoring and postoperative completion assessment are contentious areas, which evoke considerable debate at vascular meetings. It is therefore interesting to note that 34% of cases had no monitoring at all, 34% had transcranial monitoring and 21% had stump pressure monitoring, although this is clearly not continuous in most instances and may effectively be regarded as "no monitoring". Again, there was no increased risk associated with lack of monitoring. The majority of cases (66.4%) likewise did not have any objective form of intraoperative completion assessment, with no demonstrable increase in stroke risk. The results of the present study are reassuring in that they demonstrate a standard of practice in members of the VSS which is consistent with or better than currently accepted guidelines for carotid surgery, with the exception of delays from insult episode till surgery. It is easy, therefore, to become complacent and to allow standards to fall. It is important to realise that many members of the VSS still do not perform carotid surgery, either because they feel that they do too few to get sufficient experience or because they feel that their support infrastructure is inadequate to allow them to operate. Such discretion should be applauded, for it is only by adopting a program of continual surveillance and attention to outcome that carotid surgery will remain a cost-effective and relatively safe procedure.[16]

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