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Staged carotid endarterectomy under local anaesthetic in patients requiring cardiac surgery

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ABSTRACT

INTRODUCTION There is no clear guidance as to the management of carotid stenotic disease prior to cardiac surgery. We aimed to review the results of a single centre performing carotid endarterectomy (CEA) under local anaesthesia prior to cardiac surgery.

PATIENTS AND METHODS All patients referred for cardiac surgery in our tertiary referral unit between January 1998 and August 2008 were identified and data relating to those 100 undergoing CEA prior to cardiac surgery were reviewed. Eighty had coronary artery bypass grafting (CABG) alone, 15 combined valve surgery and CABG and three underwent isolated valve surgery. Two patients died prior to cardiac surgery.

RESULTS One hundred patients were prospectively identified after screening by clinical features and carotid duplex scanning to require CEA from a total of 11,394. The stroke rate was 1% between CEA and cardiac surgery, 2% following cardiac surgery and 3% in total. Ninety-eight patients proceeded to cardiac surgery (two deaths post-CEA). The cumulative event rate (stroke, myocardial infarct [included in view of the nature of the patients in our cohort] and/or death) was 10.2% following all cardiac surgery (CABG and valve). In 80 patients undergoing CABG only, the cumulative event rate was 7.5% after CABG. Including the two deaths pre-cardiac surgery, the rates were 12% and 8%. The risk of peri-operative stroke and 30-day mortality were reduced to that of patients undergoing cardiac surgery without significant carotid arterial disease, 3% versus 3.3% and 5.1% versus 6.5%, respectively.

CONCLUSIONS This study demonstrates that a policy of selective screening for significant carotid artery disease in cardiac surgical patients combined with a strategy of CEA under local anaesthesia prior to unselected cardiac surgery (CABG with or without valve surgery) leads to rates of peri-operative CVA, myocardial infarction and death comparable to rates published for CEA prior to isolated CABG surgery. Furthermore, it reduces the risk of peri-operative stroke and 30-day mortality to that observed in patients undergoing cardiac surgery without significant carotid arterial disease.

KEYWORDS

Carotid endarterectomy – Local anaesthesia – Cardiac surgery

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The incidence of major cerebrovascular accidents (CVAs) after cardiac surgery has been reported as ranging from 1–6%.[1] Significant carotid artery atherosclerotic disease is a major risk factor for developing post cardiac surgery CVAs.[2,3] For selected patients, particularly those patients with significant carotid artery stenosis with or without ipsilateral symptoms, surgery in the form of a carotid endarterectomy (CEA) may decrease the incidence of CVAs associated with cardiac surgery.[4] The timing of the CEA relative to the cardiac procedure, however, remains an issue of debate. CEA can be performed before, synchronous with, or after cardiac surgery.

Cardiac surgery before CEA, so-called ‘reversed-stage approach’ has been shown to result in the highest rate of ipsilateral CVA and any CVA.[5] Performing the CEA and cardiac surgery simultaneously has been shown to reduce the incidence of ipsilateral CVA[6–9] and this approach has also been shown to reduce cost.[10] However, morbidity and mortality remain high with death or major CVA rates of 11.5% in a recent systematic review of 94 studies.[11]

The staged approach with CEA prior to cardiac surgery is also widely used.[12–14] The main disadvantages are the risk of myocardial infarction during the CEA procedure and the risks of delaying cardiac surgery, particularly in high-risk cardiac patients. Several studies have reported high rates of peri-operative myocardial infarction and death during CEA with the staged approach.[15,16] However, recent studies excluding high-risk cardiac surgical patients have shown more promising results with a peri-operative myocardial infarction rate of 3.1% during CEA.[17] Haemodynamic instability associated with general anaesthesia during the CEA procedure is one of the main causes of peri-operative myocardial infarction and this has led to an increasing use of local anaesthetic techniques for CEA.[18]

In this paper, we present the results of staged CEA under local anaesthesia prior to cardiac surgery in patients with combined cardiac and extracranial carotid disease. Our aim was to provide a pragmatic picture of clinical service in a mixed population requiring cardiac surgery.

Patients and Methods

Patients

A prospective database was maintained for all patients referred for cardiac surgery in our tertiary referral unit between January 1998 and August 2008. The total number was 11,394. We did not perform a pre-study power calculation.

During this period, the unit protocol was to screen only patients identified as being at high risk for carotid artery disease prior to cardiac surgery. Patients were defined as high risk for carotid artery disease if they fulfilled one or more of the following criteria: (i) previous history of cerebrovascular accident or transient ischaemic attack; (ii) peripheral vascular disease; (iii) age over 60 years; or (iv) a carotid bruit on clinical examination. The criteria did not evolve during the study period. All patients were screened using colour flow duplex scanning of the carotid arteries in the longitudinal and transverse planes. The presence of plaque was noted and the reduction in cross-sectional luminal area was calculated utilising flow velocities (120–185 cm/s = 50–70% stenosis; 186–300 cm/s = 70–90% stenosis; > 301 cm/s = > 90% stenosis). After carotid artery duplex scanning, patients were managed depending on the severity of the carotid artery stenosis. Indications for carotid endarterectomy were: (i) bilateral stenoses of > 70% or a unilateral stenosis of > 70% with a contralateral occlusion; (ii) symptomatic unilateral stenosis of > 70% with a contralateral normal carotid or stenosis < 70%; and (iii) asymptomatic unilateral stenosis of > 90%. On this basis, 100 patients were identified as requiring CEA. It is known from the carotid trials that patients with asymptomatic stenoses derive considerably less benefit from prophylactic CEA but it is also important to bear in mind that our population differed considerably from those previously studied.

Two patients underwent synchronous CEA/cardiac surgery during the study period for critical, unstable cardiac disease in the presence of significant carotid stenotic disease. These patients do not form part of our current series.

Carotid endarterectomy

All CEAs were performed under local anaesthesia by a consultant vascular surgeon or an experienced vascular registrar under direct supervision. Regional anaesthesia was employed via a combined superficial and deep cervical block, achieved by infiltrating approximately 10–15 ml of equal amounts of 0.75% ropivicaine and 1% lignocaine into the subcutaneous tissue at the site of incision and deep to the posterior border of the ipsilateral sternocleidomastoid muscle. Intravenous fentanyl and midazolam were utilised, as required, as anxiolytics.

Awake testing was used to determine the need for carotid artery shunting during the period of carotid cross-clamping. Selective prosthetic patching, eversion endarterectomy and primary closure were used at the discretion of the operating surgeon. A total of 100 CEA procedures were performed.

Cardiac surgery

This was performed after CEA in 98 cases. All patients had cardiopulmonary bypass with standard ascending aortic and right atrium cannulation. Temperature was allowed to drift to 32ºC. Seventy-eight patients underwent cold blood antegrade cardioplegia for myocardial protection. Twenty patients were controlled with aortic cross clamping and induced ventricular fibrillation. All proximal vein grafts were anastomosed to the aorta with a side biting clamp after the aortic cross clamp had been removed and 67 patients underwent grafting using the LIMA.

Results

The indications for and summary data relating to CEA are presented in Table 1. There were 66 men, and 52 right-sided procedures. The risk factor characteristics of the cohort are shown in Table 2. All patients were on anti-platelet agents unless contra-indicated. All postoperative adverse events (stroke, death and myocardial infarction) were diagnosed by the responsible surgical team. No independent assessment was performed unless the symptoms required the input of a specialist team and patients were not routinely assessed by an independent physician postoperatively.

Table 1 Indications for CEA and operative summary

	Number
Indication for CEA	
Asymptomatic stenosis > 70% bilaterally	37
Symptomatic unilateral > 70% stenosis	15
Asymptomatic > 70% stenosis with contralateral occlusion	13
Asymptomatic unilateral greater than 90% stenosis	35
CEA operative data	
Shunt used	14
Prosthetic patch	66
Mean carotid artery clamp time	48 min (range, 1–150 min)

Table 2 Risk factor characteristics of the cohort

Risk factor	Present	Absent
Diabetes	20	80
Statin therapy	84	16
Documented hypertension	79	21
Current or previous smoking history	62	38

Carotid surgery and staging interval

All patients underwent unilateral CEA. In the 37 patients with asymptomatic bilateral internal carotid stenosis greater than 70%, the most severely stenosed side was operated upon or the dominant side if the stenoses were equal. Carotid shunts were required in 14 patients due to: seizure (1), contralateral upper limb weakness (3) and decreased conscious level (10). In all cases, the neurological symptoms resolved following shunt insertion. Twenty-six patients underwent 'in-house urgent' carotid endarterectomy prior to cardiac surgery performed during the same admission. The majority of these were patients with unstable coronary disease deemed too high-risk to be sent home prior to cardiac surgery.

Periprocedural complications are documented in Table 3. There were five major complications in the interval between CEA and cardiac surgery. One patient suffered a CVA immediately post procedure with a persistent left hemiparesis; two patients developed periprocedural myocardial infarctions. A further two patients died within 30 days (uncontrollable left ventricular failure and respiratory failure complicating pneumonia). The combined incidence of CVA, myocardial infarction and/or death between CEA and cardiac surgery was 5%.

The median staging interval between CEA and cardiac surgery was 52.3 days (range, 0–515 days). The urgency of cardiac surgery was based upon the clinical assessment of individual patients, leading to a wide range in CEA/cardiac surgery intervals (*i.e.* not all cases were 'urgent'; management was acute or elective as appropriate).

For purposes of clarity, the two patients who died before cardiac surgery were not included in the analyses of outcome. Cumulative event rates including these two patients were 12% for all cardiac surgery and 8% for CABG alone (versus 10.2% and 7.5% when these deaths were excluded).

Cardiac surgery

Eighty patients had coronary artery bypass grafting (CABG) alone, three had valve surgery alone and 15 had CABG and valve surgery. The mean aortic cross clamp time was 49 min and the mean cardiopulmonary bypass time was 77 min.

Complications after cardiac surgery are shown in Table 3.

There were two CVAs both of which affected the hemisphere contralateral to the CEA and five deaths within 30 days of surgery. The CVA patients had in one case bilateral

Table 3 Periprocedural complications following CEA and cardiac surgery

Post CEA	*n*	Post cardiac surgery	*n*
Minor			
Wound sepsis	1	Wound sepsis	1
Haematoma	6	Sternal sepsis	1
Arrhythmia	1	Arrhythmia	15
Neuropraxia – facial	1		
Neuropraxia – hypoglossal	1		
Neuropraxia – recurrent laryngeal	3		
Major			
CVA < 30 days	1	CVA < 30 days	2
Myocardial infarction < 30 days	2	Myocardial infarction < 30 days	0
Deaths* < 30 days	2	Death < 30 days	5
		ARF requiring dialysis	4
		Bleeding requiring theatre	1
		Duodenal ulcer	1

*For clarity of analysis, these two patients were subsequently excluded giving a total of *n* = 98.

stenoses of > 70% and in the other an occlusion with a contralateral stenosis of 70–99%. One patient developed atrial fibrillation following CEA but died from embolic bowel infarction 5 days after cardiac surgery. One patient suffered an intra-operative unplanned cardiac arrest during cardiac surgery, developed bronchopneumonia and required subtotal colectomy for ischaemic bowel before dying 3 days post-surgery. The third death was undiagnosed, in a patient who was admitted acutely 13 days after aortic valve replacement and died in the emergency department. No post-mortem was performed. Two deaths occurred with no available documentation of cause.

The stroke incidence in patients who had a staged CEA and cardiac surgery was 2%.

Non-CEA cardiac patients

For the purpose of comparison, data are presented in Table 4 relating to outcomes in the patient group undergoing cardiac surgery but not undergoing pre-operative CEA between 1 April 2003 and 1 April 2008. This includes patients deemed to be at low risk for carotid artery disease according to our screening protocol. It also includes screened patients in whom the severity of carotid artery disease was not sufficient to warrant CEA before cardiac surgery. Certain caveats apply to these data: it does not include patients who had CABG with another procedure (*e.g.* aneurysmectomy, atrial septal defect repair, atrial myxoma, arrhythmia surgery) or CABG + valve + another, or valve + another, or other procedures alone. Overall, deaths are accurate to > 99%. The quoted stroke rate relies purely on the data entered into the hospital data collection system by juniors at discharge. Valve alone data are for all valve procedures – there is no distinction between aortic, mitral and tricuspid (very few pulmonary valve replacements were performed).

Discussion

Although post-cardiac surgical CVA is multifactorial in origin, carotid artery disease is one of the major risk factors. In cardiac centres where routine carotid Doppler screening of all patients having cardiac surgery is performed, the prevalence of significant carotid artery disease ranges from 3–12%.[19] In our centre, we have adopted a strategy of targeted screening which resulted in only 100 patients requiring CEA prior to cardiac surgery (0.9% of the 11,394 cardiac surgical patients operated upon). Despite this, our CVA rate after cardiac surgery over the last 9 years has consistently remained between 1–2%.

A recent review observed that the risk of stroke after cardiac surgery was less than 2% in patients with no significant carotid disease, 3% in asymptomatic patients with unilateral 50–99% stenosis, increasing to 5% in those with bilateral 50–99% stenosis and 7–11% in patients with carotid occlusion,[20] which confirms the generally accepted view that the risk of CVA after cardiac surgery is proportionate to the burden of carotid artery disease. In a subsequent systematic review of outcomes following staged or synchronous CEA and cardiac surgery, 10–12% of patients suffered death or major cardiovascular morbidity within 30 days of surgery.[5] Our unit adopted the staged approach of CEA before cardiac surgery because of poor results reported from the combined approach and because of promising early results of CEA under local anaesthesia. Using this strategy, the stroke rate was 2% after cardiac surgery and the cumulative event rate (CVA, myocardial infarction or death) 7.2%, the global cumulative event rate was 12%. These results compare favourably with the published results of CEA under general anaesthesia prior to cardiac surgery[11] and published data from meta-analysis (Table 4). Furthermore, it can be demonstrated that our strategy reduces the risk of peri-operative stroke and death for patients with significant carotid stenotic disease (defined by our screening process) to that of patients without significant carotid stenotic disease. No attempt has been made to correlate adverse events with use of a shunt or technique of endarterectomy/arteriotomy closure as the actual incidence of events was so low as to make such an analysis meaningless. Similarly, no attempt was made to analyse adverse events in terms of secondary preventative measures/anaesthetic technique.

It is important to distinguish comparisons between cohorts of patients undergoing CABG only and those undergoing CABG plus valve surgery or valve surgery alone because it is recognised that any valve surgery carries a much higher mortality rate (Table 4).[21] For patients undergoing CABG, the event rate in our series is lower than the published data with a cumulative event rate of 7.5% versus 10.2–11.5%.

Furthermore, the rates of stroke and death are similar between the non-CEA group and the CEA group who would have been at higher risk of peri-operative events without endarterectomy, assuming our screening protocol is effective in excluding those with most severe carotid artery disease. This may relate to a decrease in the peri-operative haemodynamic instability of patients having CEA under local anaesthesia compared with CEA under general anaesthesia. In a randomised clinical trial of 531 patients comparing CEA under local anaesthesia and general anaesthesia, local anaesthesia techniques decreased intra- and postoperative haemodynamic variability, decreased the use of vasoactive drugs during surgery, decreased intensive care admissions and decreased cardiac complications.[18] However, the GALA trial failed to demonstrate a significant difference in peri-operative events between patients randomised to general anaesthesia or local anaesthesia for their CEA with event rates of 4.8% and 4.5% respectively (paradoxically, a higher incidence of cardiac events were noted in the local anaesthesia group, which is counter-

Table 4 Comparison of our data for local anaesthetic CEA with published rates based on systematic review[5]

		D	MI	S	D & S	D & S & MI
Systematic review[5]						
	Staged CEA/CABG	3.9%	6.5%	2.7%	6.1%	10.2%
	Synchronous CEA/CABG	4.6%	3.6%	4.6%	8.7%	11.5%
	Staged CABG/CEA	2%	0.9%	6.3%	8.3%	8.2%
Derriford data						
CEA first						
	CEA/CABG (*n* = 80)	3.7% (3)	1.2% (1)	2.5% (2)	6.2% (5)	7.5%* (6)
	CEA/valve ± CABG (*n* = 18)	11.1% (2)	5.5% (1)	5.5% (1)	16.6% (3)	22.2% (4)
	CEA/all cardiac surgery (n = 98)	5.1% (5)	2% (2)	3% (3)	8.1% (8)	10.2%* (10)
Non-CEA cardiac surgery						
	CABG	1.4%	N/A	1%	2.4%	N/A
	CABG/valve	5.1%	N/A	2.3%	7.4%	N/A
	Cumulative	6.5%	N/A	3.3%	9.8%	N/A

CEA first, CEA prior to cardiac surgery.
Non-CEA cardiac surgery, events in cardiac patients not undergoing pre-operative CEA. All relate to events < 30 days.
Figures in parentheses, absolute numbers.
D, death; MI, myocardial infarction; S, stroke (all types); N/A, not available.
*Cumulative event rates 8%/12% if includes two patients dying after CEA and before CABG.

intuitive if the argument of haemodynamic instability during general anaesthesia is applied).[22] Strictly speaking, these patients are not comparable with those recruited to the GALA study because they were are considered to be particularly high risk. We are not comparing local anaesthesia with general anaesthesia because they are concerned about the potential myocardial infarction rate if general anaesthesia was used in this particularly high-risk group.

Recent data[23] have suggested, as an alternative to surgical endarterectomy in unstable cardiac patients, that carotid stenting may offer equivalent or even improved outcomes in terms of peri-procedure stroke and death rates at the expense of a higher long-term rate of restenosis.[24] Consensus guidelines[25] recommend that stenting for carotid disease is suitable only for high-risk patients in high-volume centres and a proportion of our patients would meet this requirement – further data may emerge to support this as an alternative strategy. We as a unit do not currently offer carotid stenting and so we have no experience of the technique

Interestingly, two patients had a CVA after cardiac surgery even though their carotid artery disease had been treated by CEA. Both had strokes affecting the cortex contralateral to the operated side: one had bilateral greater than 90% stenosis, the second had a > 70% stenosis contralateral to an occlusion. Possible causes could include particulate emboli during aortic manipulation either during aortic cannulation or during application of the aortic side biting clamps for performing the vein–graft aorta anastomosis, air emboli, haemodynamic instability during cardiopulmonary bypass or inadequate intracerebral cross-perfusion. Irrespective, it is evident that eliminating carotid artery disease will not completely exclude CVA as a complication of cardiac surgery.

This study is a single-centre prospective series. The patients studied represent an unselected population presenting for cardiac surgery filtered by their need for CEA. Although the criteria for employing duplex screening of the carotids may be debated, our peri-operative stroke rate is low. It might be that unselected duplex scanning would highlight more patients who could be offered prophylactic CEA. Conversely, such a strategy would potentially increase the number of procedures which would otherwise not have been performed and, therefore, the number of avoidable complications. It is also true that acute cardiac deterioration would be more difficult to manage in patients with acute cardiac decompensation during an local anaesthesia procedure, although this did not occur in any of the patients in our series.

No patients in our series underwent cardic surgery without CEA. Historical data suggest that patients with severe carotid disease who require cardiac surgery do worse than those without carotid disease. The hypothesis is that if one can safely correct the carotid disease prior to cardiac surgery, *i.e.* without increasing the overall complication rate, one would expect the outcome to be similar to those without carotid disease. That is exactly what this series demonstrates. The fact that the outcomes are similar is in itself evidence of 'gain', *i.e.* the risk of cardiac surgery in those with severe carotid disease has potentially been reduced to the same risk as those without severe carotid disease.

A prospective, randomised controlled trial remains the best way to evaluate the effectiveness of different strategies in the management of carotid artery disease prior to cardiac surgery. However, because of the relative low incidence of post cardiac surgery CVA, such a trial would take several years in order to recruit a sufficient number of patients in a single centre, or involve multiple centres with the risk of creating a non-homogenous group of patients and management protocols.

Conclusions

This study demonstrates that a policy of selective screening for significant carotid artery disease in cardiac surgical patients combined with a strategy of CEA under local anaesthesia prior to unselected cardiac surgery (CABG with or without valve surgery) leads to rates of peri-operative CVA, myocardial infarction and death comparable to rates published for CEA prior to isolated CABG surgery. Furthermore, it reduces the risk of peri-operative stroke to that of patients undergoing cardiac surgery without significant carotid arterial disease (3% vs 3.3%) with a reduction in 30-day mortality (5.1% vs 6.5%).

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