ELSEVIER SCIENCE
www.elsevier.com/locate/cardiosur

PII: S0967-2109(01)00113-2

Cardiovascular Surgery, Vol. 10, No. 2, pp. 111–115, 2002

0967-2109/02 $22.00

Combined coronary artery bypass and carotid endarterectomy: long-term results

Daniel Char*, Salvador Cuadra*, John Ricotta*, Thomas Bilfinger, Fabio Giron*, Allison McLarty, Irvin Krukenkamp#, Adam Saltman# and Frank Seifert#

**Department of Surgery, Division of Vascular Surgery, Stony Brook University Hospital, Stony Brook, NY 11794, USA and #Department of Surgery, Division of Cardiothoracic Surgery, Stony Brook University Hospital, Stony Brook, NY 11794, USA*

Purpose: We determined late survival, freedom from late stroke, and freedom from late cardiac events in patients treated by combined coronary artery bypass and carotid endarterectomy (CAB/CEA).

Methods: All patients who underwent CAB/CEA in our institution between January 1994 and December 1999 were identified. Follow-up data were obtained from office records and telephone interviews. Endpoints included death from any cause, stroke, and non-fatal cardiac events (MI, CHF, percutaneous transluminal angioplasty with stenting, redo CAB). Data were expressed in life table format.

Results: Over a 6-yr period 154 patients had combined CAB/CEA with a 3.9% postoperative stroke rate. Six patients (3.9%) died, leaving 148 patients for follow-up. Average follow-up was 38±23 months (range: 1–82 months). During the follow-up period two patients (1.4%) had late strokes and 17 patients (11%) had late non-fatal cardiac events. The late mortality rate was 13% (19 patients). Of the late mortalities, four were related to cardiac disease and one to stroke. Using Kaplan–Meier analysis, the 5-yr survival probability was 80±4.3%. The freedom from late ipsilateral neurologic events was 98±1.3% at 5 yr. The freedom from late cardiac events was 82±4.6% at 5 yr.

Conclusions: The large majority of patients with combined coronary and carotid artery disease can be expected to live for greater than 5 yr. Therefore, these patients should be considered candidates for prophylactic CEA for stroke prevention, even when their carotid lesions are asymptomatic. Successful CAB/CEA provides good long-term survival and freedom from late cardiac events, as well as excellent freedom from late stroke. Further reduction in perioperative events will make this operative approach even more attractive in patients with combined disease.

Keywords: carotid stenosis, coronary artery disease, carotid endarterectomy

Introduction

Patients with atherosclerosis commonly require surgical intervention for both coronary artery disease (CAD) and carotid stenosis (CS). In patients undergoing coronary artery bypass (CAB), the incidence of CS greater than 75% documented by preoperative duplex scanning ranges from 4.7 to 8.7% [1, 2]. In patients presenting with CS, significant CAD may be present. Hertzer and associates reported that 28% of patients with extracranial cerebrovascular disease had severe correctable CAD

Correspondence to: Daniel Char, MD, 96 Aspen Drive East, Woodbury, NY 11797, USA. Tel. +1-631-444-1279; Fax: +1-631-444-8947; e-mail: cdanieljay@aol.com

documented by arteriography [3]. Patients with concomitant CAD and CS requiring surgical intervention can be approached with a combined CAB and carotid endarterectomy (CEA) procedure. Combined CAB/CEA can be accomplished with acceptable perioperative morbidity and mortality [4]. Long-term follow-up of patients who require either CEA or CAB has yielded good results. Civil and associates reported long-term results on 232 patients who underwent CEA. With a mean follow-up of 22 months, the stroke rate was 2.2% and the mortality was 9.9% [5]. Meyers and associates reported the 5 and 10-yr survival after CAB to be 90% and 74%, repectively [6]. Relatively little data is available on the long-term follow-up of combined CAB/CEA patients. The purpose of this study is to determine the long-term results of combined CAB/CEA, specifically late survival, freedom from late stroke and freedom from late cardiac events.

Patients and methods

Patient assessment and conduct of operation

Between January 1, 1994 and December 31, 1999 all patients who underwent combined CAB/CEA at our institution were identified from our database. Preoperative assessment of carotid artery disease was performed by duplex scanning and confirmed with carotid angiography or magnetic resonance angiography as needed. At the time of operation all patients were asymptomatic with regards to their carotid artery disease. No patient reported a transient ischemic attack or stroke within 4 weeks prior to the procedure.

For all combined CAB/CEA cases, the CEAs preceded median sternotomy and coronary revascularization. Patients were normothermic at the time of CEA and a carotid shunt was employed. An onlay patch closure of the endarterectomy was performed using saphenous vein or Dacron.

In all cases, coronary revascularization followed CEA via a median sternotomy. Eight patients of 154 had coronary artery bypass without the use of cardiopulmonary bypass. For all cardiopulmonary bypass patients, mild hypothermia to 32°C was used. Standard aortic cannulation and 2-stage venous cannulation was used. The heart was arrested with antegrade and retrograde blood cardioplegia. Mean arterial pressure was maintained above 50 mmHg at all times. The proximal anastomoses were constructed with the crossclamp in place or by using a partial occluding aortic clamp. All neck incisions were closed and drained after the cardiac procedure and the administration of protamine.

Long-term assessment

Long-term follow-up data were obtained from individual interviews with patients or families. All medical records were reviewed.

Statistics

Kaplan–Meier analysis was used to estimate the long-term freedom from events (death, stroke, cardiac events). StatView software (Abacus Concepts, Berkeley, CA) was employed for statistical analysis.

Results

Demographic data

From January 1, 1994 to December 31, 1999, 154 patients underwent combined CAB/CEA. Seventy percent of the patients were male (108) and 30% were female (46). The average age was 68 years (range 42–85). *Table 1* summarizes the preoperative clinical findings for all patients.

Thirty-day outcomes

The 30-day mortality rate was 3.9% (six patients). No stroke related deaths occurred. The 30-day stroke rate was 3.9% (six patients). Of the six perioperative strokes, three occurred ipsilateral to the CEA and two contralateral to the CEA. One patient had diffuse cerebral involvement.

Long-term outcomes

With six deaths in the perioperative period, 148 patients were available for long-term follow-up. The average follow-up was 38±23 months (range: 1–82 months). During the follow-up period, two patients (1.4%) had late strokes. One occurred 4 months postoperatively and was ipsilateral to the CEA. The

Table 1 Preoperative clinical findings

Factor #	Patients (%)
Hypertension	111 (72%)
Diabetes	43 (28%)
Chronic renal insufficiency[1]	8 (5%)
Dialysis dependent	6 (4%)
History of smoking	40 (26%)
Prior CVA	21 (14%)
CHF	20 (13%)
COPD	19 (12%)
EKG evidence of LVH	14 (9%)
Ejection fraction<30%[2]	25 (16%)
Left main disease	42 (14%)
Preoperative IABP	22 (14%)
Contralateral carotid stenosis>70%	12 (7%)
Contralateral carotid occlusion	3 (2%)
1=creatinine>2.5	
2=average EF 41%	

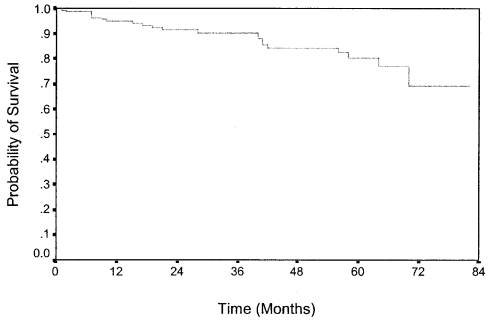
Table 2 Late deaths

Cause	# Patients
Cardiac related	
CHF	1
Myocardial infarction	3
Neurologic related	
CVA	1
Other	
Infected peripheral prosthesis	1
Malignancy	6
Pneumonia	4
Bowel ischemia	1
Renal failure	1
Pancreatitis	1
Unknown	2
Total	21

second stroke occurred 9 months postoperatively and had diffuse cerebral involvement. The late mortality rate was 14% (21 patients). Of the late mortalities, four were related to cardiac events and one to stroke. *Table 2* lists the causes of late deaths.

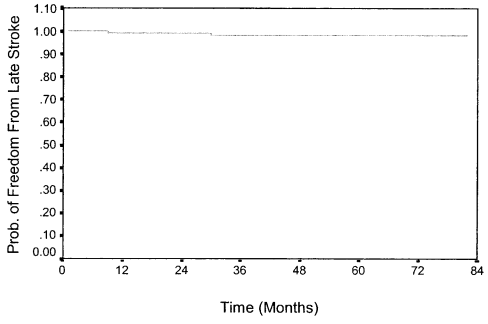
During the follow-up period, 19 patients (12%) reported late non-fatal cardiac events. These events included six myocardial infarctions, eight admissions for CHF, seven cardiac events requiring PTCA±stenting and one redo-CABG.

Using Kaplan–Meier analysis, the 5-yr survival probability was 80±4.3% (see *Figure 1*). The freedom from late ipsilateral stroke was 98±1.3% at 5 yr (see *Figure 2*). The freedom from late non-fatal cardiac events was 82±4.6% at 5 yr (see *Figure 3*).



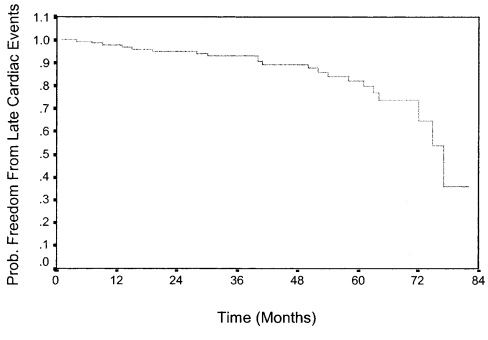
Months Postop	Number of Patients Entering	Number Withdrawn	Number at Risk	Number Deaths	Proportion Surviving	Cumulative Portion Surviving	Standard Error(%)
0-12	148	21	137.5	7	.9491	.9491	1.8
13-24	120	17	111.5	4	.9641	.9150	2.4
25-36	99	16	91	1	.9890	.9050	2.6
37-48	82	23	70.5	5	.9291	.8408	3.6
49-60	54	15	46.5	2	.9570	.8046	4.3
61-72	37	27	23.5	2	.9149	.7362	6.1

Figure 1 Kaplan–Meier curve showing survival in combined CAB/CEA



Months Postop	Number of Patients Entering	Number Withdrawn	Number at Risk	Number Strokes	Proportion Surviving	Cumulative Portion Surviving	Standard Error(%)
0-12	148	27	134.5	1	.9926	.9926	0.7
13-24	120	21	109.5	0	1.000	.9926	0.7
25-36	99	16	91	1	.9890	.9817	1.3
37-48	82	28	68	0	1.000	.9817	1.3
49-60	54	17	45.5	0	1.000	.9817	1.3
61-72	37	29	22.5	0	1.000	.9817	1.3

Figure 2 Kaplan–Meier curve showing freedom from late stroke in CAB/CEA



Months Postop	Number of Patients Entering	Number Withdrawn	Number at Risk	Number Cardiac Events	Proportion Surviving	Cumulative Portion Surviving	Standard Error(%)
0-12	148	25	135.5	3	.9779	.9779	1.2
13-24	120	18	111	3	.9730	.9519	1.9
25-36	99	15	91.5	2	.9781	.9311	2.3
37-48	82	25	69.5	3	.9568	.8909	3.2
49-60	54	13	47.5	4	.9158	.8159	4.6
61-72	37	26	24	3	.8750	.7139	6.8

Figure 3 Kaplan–Meier curve showing freedom from late cardiac events in CAB/CEA

Discussion

Several series of combined CAB/CEA have been reported with few details on long-term follow-up. Rizzo and associates reported a 5.5% perioperative mortality rate and a 5.5% perioperative stroke rate in 127 patients undergoing combined CAB/CEA [7]. Darling and associates reported a perioperative mortality and stroke rate of 2.4% and 1.7%, respectively [8]. Higher perioperative morbidity and mortality rates have been reported in the literature, such as the mortality and stroke rates of 8% and 9%, respect-

ively reported by Mackey and associates [9]. However, this series contained a high incidence of symptomatic carotid disease and contralateral occlusions. Our mortality rate of 3.9% (6 patients) and stroke rate of 3.9% (six patients) appear comparable to others reported in the literature. According to the New York State Department of Health databank model, the predicted mortality for our series of patients is 3.7%. Of the observed strokes in our series, only one-half were ipsilateral to the CEA (1.95%). However, it is difficult to compare different single-institution series because of the wide variations in patient demographics between series such as the incidence of symptomatic or bilateral carotid disease and the presence or absence of other preoperative risk factors.

Long-term results of CEA patients have reported excellent rates of freedom from stroke. Civil et al reported a 2.2% stroke rate in 232 patients after a mean follow-up of 22 months [5]. Reported actuarial 5-yr rates for freedom from stroke after CEA have ranged from 87% to 90% [10, 11]. Long-term survival after CEA has been reported with good results. Actuarial 5-yr survival after CEA has ranged from 72% to 82%. Follow-up of CEA patients often reveals myocardial infarction as a common cause for late deaths. Hertzer and Arison found that 37% of late deaths after CEA were secondary to myocardial infarction [11]. Similarly, Mackey *et al.* found that 31% of late deaths after CEA where due to myocardial infarction in patients with known coronary disease. Even in patients without known coronary disease, 30% of late deaths were due to myocardial infarction and, overall, 49% of late deaths in this series of CEA patients were cardiac related (myocardial infarction and congestive heart failure) [12].

The large majority of patients with synchronous coronary and carotid artery disease undergoing combined CAB/CEA can be expected to live for periods greater than 5 yr. Our data show a 5-yr survival probability of 80±4.3%. Seventy four percent of the late deaths were not related to cardiac or neurological events. Of the late mortalities, four were related to cardiac events and one to stroke. Others have reported the 5-yr survival probability after combined CAB/CEA to be from 70±5% to 78.9±2.6% [7, 13].

In addition to the good 5-yr survival probability obtained in our series, excellent long-term freedom from late stroke was observed. Only two patients had late strokes yielding a probability of freedom from late stroke of 98±1.3% at 5 yr. This high probability of freedom from late stroke has been observed by others [7, 13, 14]. When comparing our long-term results of combined CAB/CEA patients to CEA patients, the combined CAB/CEA patients enjoy the same benefits of excellent long-term freedom from stroke and long-term survival. In addition, our series of combined CAB/CEA patients have good long-term freedom from cardiac events as only 22% of long-term deaths were due to cardiac events. When compared to CAB patients, combined CAB/CEA patients do not have the same long-term survival. Long-term follow-up of CAB patients has shown an actuarial 5-yr survival of 90% [6, 15]. However, patients requiring combined CAB/CEA tend to be older, as in our series, and have more co-morbid conditions than CAB patients. As suggested by Hertzer *et al.*, this may contribute to their inferior long-term survival [16].

Conclusion

Patients requiring combined CAB/CEA enjoy excellent long-term freedom from stroke, as well as, good long-term survival. These long-term results are similar to those observed in CEA patients. In addition, combined CAB/CEA patients have good freedom from cardiac events and a decrease proportion of late deaths attributable to myocardial infarction. Therefore, identifying and treating coronary artery disease in CEA patients should be pursued. In addition, identifying and treating carotid artery disease in CAB patients results in excellent long-term freedom from stroke. Further reduction in perioperative events will make this operative approach even more attractive in patients with combined disease.

References

1. Ricotta, J. J., Faggioli, G. L., Castilone, A. *et al.*, Risk factors for stroke after cardiac surgery: Buffalo Cardiac–Cerebral Study Group. *Journal of Vascular Surgery*, 1995, **21**, 359–364.
2. Faggioli, G. L., Curl, G. R. and Ricotta, J. J., The role of carotid screening before coronary artery bypass. *Journal of Vascular Surgery*, 1990, **12**, 724–731.
3. Hertzer, N. R., Young, J. R., Beven, E. G. *et al.*, Coronary angiography in 506 patients with extracranial cerebrovascular disease. *Archives of Internal Medicine*, 1985, **145**, 849–852.
4. Akins, C. W., Moncure, A. C., Daggett, W. M. *et al.*, Safety and efficacy of concomitant carotid and coronary artery operations. *Annals of Thoracic Surgery*, 1995, **60**, 311–318.
5. Civil, I. D., O'Hara, P. J., Hertzer, N. R. *et al.*, Late patency of the carotid artery after endarterectomy. Problems of definition, follow-up methodology, and data analysis. *Journal of Vascular Surgery*, 1998, **8**(1), 79–85.
6. Myers, W. O., Blackstone, E. H., Davis, K. *et al.*, CASS registry long term surgical survival. *Journal of the American College of Cardiology*, 1999, **32**(2), 488–498.
7. Rizzo, R. J., Whittemore, A. D., Couper, G. S. *et al.*, Combined carotid and coronary revascularization: the preferred approach to the severe vasculopath. *Annals of Thoracic Surgery*, 1992, **54**, 1099–1109.
8. Darling, R. C., Dylewski, M., Chang, B. B. *et al.*, Combined carotid endarterectomy and coronary artery bypass grafting does not increase the risk of perioperative stroke. *Cardiovascular Surgery*, 1998, **6**(5), 448–452.
9. Mackey, W. C., Khabbaz, K., Bojar, R. *et al.*, Simultaneous carotid endarterectomy and coronary bypass: perioperative risk and long-term survival. *Journal of Vascular Surgery*, 1996, **24**, 58–64.
10. Maini, B. S., Mullins, T. F., Catlin, J. *et al.*, Carotid endarterec-

tomy: a ten-year analysis of outcome and cost of treatment. *Journal of Vascular Surgery*, 1990, **12**, 732–740.
11. Hertzer, N. R. and Arison, R., Cumulative stroke and survival ten years after carotid endarterectomy. *Journal of Vascular Surgery*, 1985, **2**, 661–668.
12. Mackey, W. C., O'Donnell, T. F. and Callow, A. D., Cardiac risk in patients undergoing carotid endarterectomy: impact on perioperative and long-term mortality. *Journal of Vascular Surgery*, 1990, **11**, 226–234.
13. Minami, K., Kukahara, K., Boethig, D. *et al.*, Long-term results of simultaneous carotid endarterectomy and myocardial revascularization with cardiopulmonary bypass used for both procedures. *Journal of Thoracic and Cardiovascular Surgery*, 2000, **119**, 764–773.
14. Plestis, K. A., Ke, S., Jiang, Z. D. *et al.*, Combined carotid endarterectomy and coronary artery bypass: immediate and long-term results. *Annals of Vascular Surgery*, 1999, **13**, 84–92.
15. Hall, R. J., Elayda, M. A., Gray, A. *et al.*, Coronary artery bypass: long-term follow-up of 22,284 consecutive patients. *Circulation*, 1983, **68**(Suppl II), II–20.
16. Hertzer, N. R., Loop, F. D., Bevan, E. G. *et al.*, Surgical staging for simultaneous coronary and carotid disease: a study including prospective randomization. *Journal of Vascular Surgery*, 1989, **9**, 455–463.