Interventional Cardiology

Staged Carotid Angioplasty and Stenting Followed by Cardiac Surgery in Patients With Severe Asymptomatic Carotid Artery Stenosis
Early and Long-Term Results

Jan Van der Heyden, MD; Maarten J. Suttorp, MD, PhD; Egbert T. Bal, MD; Jef M. Ernst, MD, PhD; Rob G. Ackerstaff, MD, PhD; Jeroen Schaap, MD; Johannes C. Kelder, MD; Mark Schepens, MD, PhD; Herbert W. Plokker, MD, PhD

Background—The strategy for treating patients with severe asymptomatic carotid artery stenosis and cardiac disease remains unresolved. Staged or combined carotid endarterectomy in these patients offers the potential benefit of decreased neurological morbidity during and after cardiac surgery; however, in high-risk patients with severe coronary artery disease, chronic obstructive pulmonary disease, or renal impairment, the incidence of death and stroke is significantly higher.

Methods and Results—We report the results of a prospective, single-center study designed to evaluate the feasibility and safety of carotid artery angioplasty and stenting (CAS) before cardiac surgery in neurologically asymptomatic patients. The periprocedural and long-term outcomes of 356 consecutive patients who underwent CAS before cardiac surgery were analyzed. The procedural success rate of CAS was 97.7%. The death and stroke rate from time of CAS to 30 days after cardiac surgery was 4.8% (n=17). The myocardial infarction rate from time of CAS to 30 days after cardiac surgery was 2.0% (n=7), and the combined death, stroke, and myocardial infarction rate was 6.7% (n=24). Distal embolic protection devices were used in 40% of the cases.

Conclusions—This large cohort of asymptomatic patients who underwent staged CAS and cardiac surgery experienced a low periprocedural complication rate. The high rate of freedom from death and stroke during the 5 years of follow-up supports the long-term durability of this approach. Our findings suggest that this new strategy may become a valuable alternative in the treatment of patients with combined carotid and cardiac disease. (Circulation. 2007;116:000-000.)

Key Words: atherosclerosis ■ carotid arteries ■ cardiovascular diseases ■ cerebrovascular circulation ■ cardiopulmonary bypass

In the absence of randomized trials, the best management of patients with concomitant severe carotid and coronary artery disease remains in dispute, particularly in asymptomatic patients. The incidence of perioperative stroke that occurs in patients with coexistent asymptomatic carotid disease undergoing cardiac surgery varies from 3% to 11%, depending on the severity of carotid stenosis. The prevalence of significant carotid artery stenosis in patients who undergo coronary artery bypass grafting (CABG) ranges from 3% to 22%. This variation depends on the frequency, rigidity of screening, and definition of “significant” carotid artery stenosis used. It has been demonstrated that the presence of severe carotid artery stenosis correlates with the severity of coronary artery disease. The cause of perioperative neurological events during heart surgery is multifactorial; however, evidence suggests that in most patients, hypoperfusion due to a severely stenotic carotid artery or embolization from an ulcerative plaque could be the responsible mechanism. Ischemic neurological injury during cardiopulmonary bypass caused by inevitable relative hypotension would be difficult to avoid in patients with severe carotid stenosis. During cardiopulmonary bypass, cerebral autoregulation is severely impaired, which makes cerebral blood flow directly proportional to cerebral perfusion pressure. This finding provided a logical reason for the initial trials of combined or staged carotid endarterectomy (CEA) in these patients in an attempt to reduce perioperative mortality.

Editorial p ●●●
Clinical Perspective p ●●●

Even though we have achieved good results with combined CEA and CABG at our center, this approach requires long...
operative times. Recent studies have shown that carotid angioplasty and stenting (CAS) is a feasible and effective minimally invasive technique.\textsuperscript{13-15} The effect of CAS on the incidence of death and stroke after cardiac surgery remains unclear. The expected benefit of a reduction in myocardial infarction (MI) rates is yet to be proved; however, in high-risk CEA patients, carotid stenting has proved superior to CEA.\textsuperscript{16} We report the results of CAS and subsequent cardiac surgery in 356 patients with asymptomatic severe carotid artery disease.

### Methods

**Patient Population**

In a prospective, nonrandomized study, we analyzed 364 consecutive patients scheduled for CAS and cardiac surgery from December 1997 to June 2005 at our center. Patients were considered asymptomatic if an ipsilateral cerebrovascular event had not occurred within the prior 4 months. Significant carotid artery disease was defined as luminal diameter reduction of $>80\%$, according to North American Symptomatic Carotid Endarterectomy Trial criteria.\textsuperscript{17,18} The indications for cardiac surgery were symptomatic (documented myocardial ischemia) severe coronary artery disease (including bypass failure) not eligible for percutaneous revascularization, symptomatic valve disease, and disease (aneurysm/dissection) of the ascending aorta or arch that demanded reconstructive surgery. Patients were excluded if they had severe renal impairment (serum creatinine $\geq 300$ \textmu mol/L), peripheral vascular disease that precluded femoral artery access, major neurological deficit, or any other illness that impeded their ability to provide informed consent. Patients with severe diffuse atherosclerosis of the common carotid artery, chronic total occlusions, and long preocclusive lesions (“string sign” lesions) were also excluded. All patients gave written informed consent. This registry was approved by the ethics committee of our hospital.

**End-Point Definition**

The primary end point of the present study was the combined incidence of death and stroke from time of CAS to 30 days after cardiac surgery. Strokes were considered disabling (major) if patients had a modified Rankin score of $>3$ at 30 days after onset of symptoms. A minor stroke was defined as a Rankin score of 3 or less that resolved completely within 30 days. Transient ischemic attack and amaurosis fugax were diagnosed if the symptoms disappeared within 24 hours. Fatal stroke was defined as death attributed to an ischemic or hemorrhagic stroke. The cause of death was obtained from the death certificate or the postmortem examination report.

Secondary end points were MI and combined death, stroke, and MI from time of CAS to 30 days after cardiac surgery. In the long-term outcome, cumulative event rates at 5 years are described. Cardiocerebrovascular mortality was reported separately and was defined as death related to a cardiac or neurological event.

The diagnosis of Q-wave MI was based on the presence of new Q waves on the ECG and an elevated creatine kinase at least 2 times the upper limit of the normal range with an elevated level of MB isoenzyme. In the absence of pathological Q waves, the diagnosis of non-Q-wave MI was based on an increase in the creatine kinase level to more than twice the upper limit of the normal range with an

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**Table 1. Baseline Clinical Patient Characteristics (n=356 Patients)**

<table>
<thead>
<tr>
<th>Event</th>
<th>CAS Patients (n=356)</th>
<th>Cardiac Surgery Patients (n=354)</th>
<th>Total (n=356)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean±SD), y</td>
<td>72.9±7.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>104 (28.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>164 (45.1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>81 (22.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypercholesterolemia</td>
<td>157 (43.1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smoking</td>
<td>72 (19.8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>History of neurological symptoms*</td>
<td>58 (15.9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previous MI</td>
<td>117 (32.1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valvular heart disease</td>
<td>88 (24.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>46 (12.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unstable angina pectoris</td>
<td>141 (38.8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previous CAG</td>
<td>47 (12.9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previous PTCA</td>
<td>47 (12.9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previous carotid angioplasty</td>
<td>7 (1.9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previous CEA</td>
<td>16 (4.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previous heart/neck radiotherapy</td>
<td>18 (4.9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulmonary disease</td>
<td>39 (10.7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Renal failure (creatinine 120–300 \textmu mol/L)</td>
<td>43 (11.8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contralateral severe ACI stenosis</td>
<td>22 (6.1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Severe stenosis or occlusion of left subclavian artery</td>
<td>5 (1.4)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Stroke or transient ischemic attack 4 months or more before CAS.

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**Table 2. Periprocedural Event Rate After Staged CAS and Cardiac Surgery**

<table>
<thead>
<tr>
<th>Event</th>
<th>CAS Patients (n=356)</th>
<th>Cardiac Surgery Patients (n=354)</th>
<th>Total (n=356)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All deaths</td>
<td>1 (0.3)</td>
<td>12 (3.4)</td>
<td>13 (3.7)</td>
</tr>
<tr>
<td>Cardiac deaths</td>
<td>1 (0.3)</td>
<td>7 (2.0)</td>
<td>8 (2.2)</td>
</tr>
<tr>
<td>Neurological deaths</td>
<td>0</td>
<td>1 (0.3)</td>
<td>1 (0.3)</td>
</tr>
<tr>
<td>Nonneurological/noncardiovascular deaths</td>
<td>0</td>
<td>4 (1.1)</td>
<td>4 (1.1)</td>
</tr>
<tr>
<td>All strokes</td>
<td>5 (1.4)</td>
<td>6 (1.7)</td>
<td>11 (3.1)</td>
</tr>
<tr>
<td>Major ipsilateral nonfatal strokes</td>
<td>1 (0.3)</td>
<td>3 (0.8)</td>
<td>4 (1.1)</td>
</tr>
<tr>
<td>Major contralateral nonfatal strokes</td>
<td>0</td>
<td>2 (0.6)</td>
<td>2 (0.6)</td>
</tr>
<tr>
<td>Minor strokes</td>
<td>4 (1.1)</td>
<td>1 (0.3)</td>
<td>5 (1.4)</td>
</tr>
<tr>
<td>Transient ischemic attacks</td>
<td>8 (2.2)</td>
<td>5 (1.4)</td>
<td>13 (3.7)</td>
</tr>
<tr>
<td>Nonfatal MIs</td>
<td>2 (0.6)</td>
<td>5 (1.4)</td>
<td>7 (2.0)</td>
</tr>
<tr>
<td>All deaths and major strokes</td>
<td>2 (0.6)</td>
<td>15 (4.2)</td>
<td>17 (4.8)</td>
</tr>
<tr>
<td>All deaths, major strokes, and MIs</td>
<td>4 (1.1)</td>
<td>20 (5.6)</td>
<td>24 (6.7)</td>
</tr>
</tbody>
</table>

*Values are n (%).*
elevated level of MB isoenzyme. After CAS and cardiac surgery, a 12-lead ECG was performed in all patients. After cardiac surgery, the ECG was performed on a daily basis during the first 48 hours; afterward, during the remaining period of hospitalization, ECGs were performed in case of unexplained chest pain.

**CAS Procedure**

Cervical-cerebral angiography was performed according to the standard technique with intracranial views to determine patency and the completeness of the circle of Willis. Patients were accepted for the percutaneous approach by a consensus decision that involved the neurologist, the cardiovascular surgeon, and the interventional cardiologist. All patients received aspirin and clopidogrel for at least 3 days before the procedure. Initial loading doses were 300 mg for both drugs, followed by 100 and 75 mg daily, respectively. All antihypertensive medication was discontinued 1 day before the procedure to decrease baroreceptor stimulation–related bradycardia and hypotension caused by balloon inflation.

Patients were not sedated before or during the procedure. Cerebral blood flow velocities in the ipsilateral middle cerebral artery (if an adequate window was available) were monitored with transcranial Doppler during the procedure. The hemodynamic status and oxygen saturation were monitored continuously. All procedures were performed via femoral access. An 8F short femoral introducer sheath was inserted, and heparin was administered intravenously (10 000 IU). The common carotid artery was engaged selectively with a diagnostic catheter (Sidewinder II, 5F, Cordis, Miami Lakes, Fla), which was exchanged for a long, 0.018-inch, stiff wire (SV-5, 300 cm, Cordis) positioned proximal to the target lesion. After this, an 8F percutaneous coronary angioplasty guiding catheter was placed in position (MP A1 8F, Cordis) and, if required, supported by a telescopic diagnostic catheter (MP A1 5F, 125 cm, Cordis). Selective angiography of the region of interest was performed; since the year 2004, 3D computed rotational angiography has become standard practice. After the lesion was crossed with a flexible coronary wire, a low-profile, undersized angioplasty balloon (3.0 to 3.5 mm) was used to predilate the lesion, followed by placement of an appropriately sized self-expandable stent. To maximize stent deployment and vessel scaffolding, postdilation was performed with a balloon (5.5 to 7.0 mm) after atropine (0.5 mg IV) was administered. In addition to angiography (rotational), duplex ultrasonography was performed to facilitate stent selection and optimal deployment. A distal cerebral protection device (FilterWire EZ system, Boston Scientific, Natick, Mass) has been available since the year 2002 and was used in every procedure, unless the lesion was considered too tight to allow the passage of the device. On completion of the procedure, ipsilateral carotid and intracranial angiography (rotational) was performed to verify angiographic success and exclude distal embolization. Procedural success was defined as successful stent deployment with a residual diameter stenosis ≤30%, as determined by postprocedural quantitative coronary angiography. After the procedure, all patients were routinely admitted for 2 to 4 hours to the medium-care or coronary care unit. All patients were evaluated clinically by a neurologist before the procedure, during the procedure, and immediately afterward. In case of a major stroke, the patient was monitored afterward on the stroke unit.

**Subsequent Cardiac Surgery**

Cardiac surgery (including coronary artery bypass, valve surgery, or reconstructive surgery of the ascending aorta) was usually scheduled 14 to 30 days after CAS, unless clinical instability dictated otherwise. Aspirin and clopidogrel were discontinued 5 days before surgery, if possible.

Our institution is a large cardiovascular referral center. It also operates as a training center for cardiologists and cardiothoracic surgeons. On a yearly basis in our hospital, we perform up to 2000 cardiothoracic surgery procedures and 2800 percutaneous interventions. During the period of enrollment, 618 CAS procedures, 9484 CABGs (1120 off-pump), 2234 valve surgery procedures, 1317 major aortic surgery procedures, and 56 combined CEA/CABG procedures were performed.

**Data Collection and Patient Follow-Up**

The mean follow-up per patient was 31 months, which resulted in a total follow-up of 910 patient-years. In case of an event, hospital notes or death certificates were consulted when possible. Telephone
follow-up interviews were conducted at 1 month and thereafter at 6-month intervals by a dedicated full-time research coordinator. An independent board-certified neurologist graded symptoms according to functional testing with the modified Rankin score if a cerebrovascular event occurred.22

Statistical Analysis
Proportions are expressed as percentage and compared between groups by means of the Fisher exact test; continuous data are expressed as mean±SD. For right-censored data (ie, time to event), the Kaplan-Meier method was used to compute the long-term survival, stroke, and MI outcomes with corresponding 95% confidence intervals. The log-rank test was used to compare groups. For all computations, SAS version 8.2 (SAS Corp, Cary, NC) was used.

The authors had full access to and take full responsibility for the integrity of the data. All authors have read and agree to the manuscript as written.

Results

Patient Characteristics
The baseline clinical characteristics of all patients are shown in Table 1.

Angiographic and Stenting Results
CAS was performed predominantly in the proximal internal carotid artery (n=341) but also included the distal (n=6) and proximal (n=9) common carotid artery. The overall procedural success rate was 97.7%. Eight technically unsuccessful procedures were due to inadequate guiding catheter position or wire support. In the data analysis, these patients were excluded. In 5 patients, concomitant left subclavian stenosis or occlusion was treated with angioplasty and stenting. Twenty-two patients (6.2%) underwent staged, bilateral CAS. A distal cerebral protection device was used in 143 patients (40.2%).

The mean angiographic degree of stenosis was reduced from 85±5% (before stenting) to 5±9%. A variety of cerebral stents were used: Easy Wall stent (Boston Scientific; 3.1%), Carotid Wall stent (Boston Scientific; 75.6%), Acculink (Guidant, Natick, Mass; 18.2%), Precise (Cordis; 2.2%), NexStent (Boston Scientific), Omnilink (Guidant), and Protégé (EV3, Plymouth, Minn).

Cardiac Surgery Results
The mean time to cardiac surgery after CAS was 22 days, with a range of 1 day to 3 months. In the present study population, 113 patients (31.7%) underwent CABG within 14 days after CAS, 111 (31.1%) after 14 to 30 days, and 132 (37.1%) after 30 days. In the present series, 319 patients (89.6%) underwent CABG, in whom 23 procedures (7.2%) were accomplished without cardiopulmonary bypass (off-pump). 97 patients (27.2%) had valve surgery (the majority of whose procedures were combined with CABG), and 17 (4.8%) underwent reconstructive surgery of the ascending aorta. Forty-seven (13.2%) of the cardiac interventions were redo procedures (second or third). Thirteen patients (3.7%) underwent combined cardiac surgery with contralateral CEA after CAS.

Periprocedural Outcome and 30-Day Follow-Up
Periprocedural event rates after CAS and after cardiac surgery are listed in Table 2. During the period between CAS and surgery, 1 cardiac death (0.3%) occurred due to cardiac arrhythmia, 2 patients (0.6%) had an MI, 5 patients (1.4%) had unstable angina, 1 patient had a major ipsilateral stroke and did not proceed to surgery (0.3%), 4 patients (1.1%) had a minor ipsilateral stroke, and 8 patients (2.2%) had a transient ischemic attack. Cardiac surgery was performed in 354 of 356 patients. Thirteen patients (3.7%) died within 30 days after cardiac surgery. The causes of death were cardiac in 8 cases, including 2 patients who could not be weaned off bypass; 4 patients died of septicemia and multiorgan failure, and 1 death was neurologically determined. In those patients in whom a nonfatal neurological event occurred after cardiac surgery, control duplex ultrasonography was performed that showed adequate stent apposition in the treated carotid artery without hemodynamically significant (re)stenosis or stent thrombosis. In the patient in whom death was neurologically determined, the CT scan showed a major cerebral hemorrhage without any carotid stent thrombosis. In patients ≥80 years of age (n=70), the cardiac and neurological death rate was significantly higher than in patients <80 years of age (n=286; 7.1% versus 1.7%, P=0.03). All cardiac and neurological deaths occurred in the immediate postoperative period. Three of the octogenarians died from Q-wave MI, 1 patient died from congestive heart failure, and 1 death was neurologically determined. Male and female patients had

Table 3. Cumulative 5-Year Event Rates (Univariate Analysis)

<table>
<thead>
<tr>
<th>Event Rate at 5 Years, % (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>All cause mortality</td>
<td>24.5 (18.0–31.0)</td>
</tr>
<tr>
<td>Cardiocerebrovascular mortality</td>
<td>16.6 (11.2–22.0)</td>
</tr>
<tr>
<td>MI</td>
<td>2.0 (0.5–3.5)</td>
</tr>
<tr>
<td>Major stroke</td>
<td>3.1 (0.1–6.0)</td>
</tr>
<tr>
<td>Minor stroke</td>
<td>2.9 (0.8–5.0)</td>
</tr>
<tr>
<td>Transient ischemic attack</td>
<td>5.6 (2.3–8.9)</td>
</tr>
<tr>
<td>All-cause mortality + minor stroke + major stroke</td>
<td>28.6 (21.8–35.3)</td>
</tr>
<tr>
<td>Cardiocerebrovascular mortality + major stroke + MI</td>
<td>20.5 (14.6–26.3)</td>
</tr>
</tbody>
</table>

CI indicates confidence interval.
*Denotes event rates at 3-year follow-up.
similar periprocedural complication rates. Although not statistically significant, periprocedural event rates were lower in patients treated with cerebral distal protection (n=143, 40.2%) than in those treated without cerebral protection (n=213, 59.8%; 2.2% versus 3.8%, P=0.50).

**Long-Term Follow-Up**

Overall median follow-up was 31 months, with 25% of the patients being followed up for >48 months. Two patients underwent repeat carotid angioplasty for restenosis at 3 and 7 months after the first procedure, respectively. In both patients, subsequent follow-up with duplex ultrasonography at 3 years showed a stabilization of the restenotic process with an estimated in-stent restenosis of 50% to 70%. Fifty-eight deaths (16.3%) occurred; 38 deaths (10.7%) were cardiac related, 4 (1.1%) were neurological, and 16 (4.5%) were of other causes. Fourteen strokes (3.9%) occurred, with 4 (1.1%) major ipsilateral nonfatal strokes, 2 (0.6%) major contralateral nonfatal strokes, 8 (2.2%) minor strokes, and 15 (4.2%) transient ischemic attacks. Seven (2.0%) nonfatal MIs occurred.

Survival at 5 years was 75.5% (95% confidence interval 69.0% to 82.0%; Figure 1). A univariate analysis showing the cumulative 5-year event rates is depicted in Table 3. No differences existed in all-cause mortality between patients ≥80 and <80 years of age or between patients treated with or without distal cerebral protection. However, the 5-year rate of freedom from all-cause mortality was significantly higher in women than in men (Figure 2). Patients ≥80 years of age had significantly higher rates of transient ischemic attack than those <80 years old. The Kaplan-Meier curve for 5-year freedom from all stroke and death is shown in Figure 3.

**Discussion**

CAS followed by cardiac surgery may provide a valuable treatment for patients with combined carotid and cardiac disease, given the low periprocedural complication rates observed in the present study. The high rate of freedom from death and stroke during the 5 years of follow-up supports the long-term durability of this approach.

The ideal strategy for treating patients with severe asymptomatic carotid artery stenosis and cardiac disease remains unclear.23 Perioperative stroke risk is thought to be <2% when carotid stenoses are <50%, 10% when stenoses are 50% to 80%, and 11% to 19% in patients with stenoses >80%. Patients with untreated bilateral, high-grade stenoses or occlusions have a 20% chance of stroke (American Heart Association/American College of Cardiology guidelines).24,25

Das et al26 observed a risk of 11.5% for stroke and death in patients with severe carotid disease undergoing isolated CABG, with an undetermined incidence of nonfatal MI. Naylor et al23 reported a 10% to 12% risk of death, stroke, or MI for staged or combined operations and concluded that staged or synchronous operations might be able to reduce the death or stroke rate. Ziada et al27 described significantly fewer adverse events in patients who underwent CAS and cardiac surgery, despite a higher baseline risk profile, than in those undergoing combined CEA and CABG. Our strategy demonstrates a favorable stroke and death risk of 4.8% and a combined risk of 6.7% for death, stroke, and MI. The reported total periprocedural MI rate of 2.0% is in contrast to observational studies of CEA and CABG, in which the rate varies from 3.6% (synchronous) to 6.5% (staged), especially when one bears in mind that in the present study population, 13% of cardiac surgical procedures were redo procedures. This new approach demonstrates a low rate of

![Kaplan-Meier curve: 5-year survival for men and women. n Indicates number at risk; solid line, males; and dashed line, females.](image-url)
ipsilateral major stroke (1.1%), especially in view of the fact that 13 patients (3.7%) underwent CAS and cardiac surgery combined with contralateral CEA.

The periprocedural cardiac and neurological death rate was higher for patients ≥80 years than for those <80 years of age. The immediate postoperative period was crucial for these octogenarians, with all fatal events occurring within 2 days of cardiac surgery. Approximately 60% of the procedures included in the present study were performed before the availability of embolic distal protection devices in our institution.

The need for repeated intervention was low in the present group of patients. This low rate is consistent with the low angiographic restenosis rate in other studies, although those studies reported on CAS of the extracranial arteries without concomitant cardiac surgery.13,14,28,29

An optimal strategy for the discontinuation of antiplatelet agents, which takes into account both adequate timing for complete carotid stent endothelialization with decreased platelet activation and a brief waiting period for cardiac surgery to reduce the incidence of cardiac events, is inconceivable.30–32 Inevitably, a compromise is required. The minimum delay between CAS and cardiac surgery should be determined by the extensiveness of the cardiac disease. In those patients who require urgent cardiac surgery, the operation should be performed without discontinuation of dual-antiplatelet therapy. If the cardiac condition warrants a prolonged delay, the optimal timing, derived from our own experience, would be between 2 and 3 weeks, and the antiplatelet drug regimen should be continued until 5 days before surgery. In the present study, 31.7% of patients underwent CABG within 14 days after CAS, 32.2% after 14 to 30 days, and 37.1% after 30 days. Because neither stent thrombosis nor increased perioperative bleeding complications were observed in these patients, this clinical practice may be the most achievable compromise. This new approach provides a less radical intervention from the patient’s point of view and therefore might reduce psychological trauma and improve the patient’s quality of life.

**Study Limitations**

This prospective, nonrandomized study cannot be compared with other trials and series of CEA because of the different composition of patient populations, especially with the inclusion in the present study of high-risk patients with severe cardiac disease. A large prospective trial with randomization either to staged CAS-CABG, combined CEA-CABG, or isolated CABG in a study population similar to ours would demonstrate the optimal therapeutic strategy.

**Conclusion**

In this large group of patients with no neurological symptoms who underwent staged CAS and cardiac surgery, a low periprocedural complication rate was found. The high rate of freedom from death and stroke during the 5 years of follow-up supports the long-term durability of this approach. These findings suggest that CAS before cardiac surgery may be a valuable alternative to the entirely surgical approach. These 2 strategies should be compared in an adequately powered randomized trial.

**Disclosures**

None.

**References**

In the absence of randomized trials, the best management of patients with concomitant severe carotid and coronary artery disease remains in dispute, particularly in asymptomatic patients. The initial studies of combined or staged carotid endarterectomy in these patients were conceived in an attempt to reduce perioperative mortality. Even though we have achieved good results with combined carotid endarterectomy and coronary artery bypass grafting at our center, this surgical combination requires long operative times. Recent studies have shown that carotid angioplasty and stenting is a feasible and effective minimally invasive technique. The effect of carotid angioplasty and stenting on the incidence of death and stroke after cardiac surgery remains unclear. The expected benefit of a reduction in myocardial infarction rates is yet to be proved; however, in high-risk carotid endarterectomy patients, carotid stenting has proved superior to carotid endarterectomy. Carotid angioplasty and stenting followed by cardiac surgery may provide a valuable treatment for patients with combined carotid and cardiac disease, given the low periprocedural complication rates in the present study. The high rate of freedom from death and stroke during our 5 years of follow-up supports the long-term durability of this strategy. This new approach provides a less radical intervention from the patient’s point of view and thus might reduce psychological trauma and improve quality of life.

CLINICAL PERSPECTIVE


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