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Short-term results of a randomized trial examining timing of carotid endarterectomy in patients with severe asymptomatic unilateral carotid stenosis undergoing coronary artery bypass grafting

Giulio Illuminati, MD,[a] Jean-Baptiste Ricco, MD,[b] Francesco Caliò, MD,[a] Maria Antonietta Pacilè, MD,[a] Fabio Miraldi, MD,[c] Giacomo Frati, MD,[c] Francesco Macrina, MD,[c] and Michele Toscano, MD,[c] *Rome, Italy; and Poitiers, France*

Objective: **This study evaluated the timing of carotid endarterectomy (CEA) in the prevention of stroke in patients with asymptomatic carotid stenosis >70% receiving a coronary artery bypass graft (CABG).**

Methods: **From January 2004 to December 2009, 185 patients with unilateral asymptomatic carotid artery stenosis >70%, candidates for CABG, were randomized into two groups. In group A, 94 patients received a CABG with previous or simultaneous CEA. In group B, 91 patients underwent CABG, followed by CEA. All patients underwent preoperative helical computed tomography scans, excluding significant atheroma of the ascending aorta or aortic arch. Baseline characteristics of the patients, type of coronary artery lesion, and preoperative myocardial function were comparable in the two groups. In group A, all patients underwent CEA under general anesthesia with the systematic use of a carotid shunt, and 79 patients had a combined procedure and 15 underwent CEA a few days before CABG. In group B, all patients underwent CEA, 1 to 3 months after CABG, also under general anesthesia and with systematic carotid shunting.**

Results: **Two patients (one in each group) died of cardiac failure in the postoperative period. Operative mortality was 1.0% in group A and 1.1% in group B ($P = .98$). No strokes occurred in group A vs seven ipsilateral ischemic strokes in group B, including three immediate postoperative strokes and four late strokes, at 39, 50, 58, and 66 days, after CABG. These late strokes occurred in patients for whom CEA was further delayed due to an incomplete sternal wound healing or because of completion of a cardiac rehabilitation program. The 90-day stroke and death rate was 1.0% (one of 94) in group A and 8.8% (eight of 91) in group B (odds ratio [OR], 0.11; 95% confidence interval [CI], 0.01-0.91; $P = .02$). Logistic regression analysis showed that only delayed CEA (OR, 14.2; 95% CI, 1.32-152.0; $P = .03$) and duration of cardiopulmonary bypass (OR, 1.06; 95% CI, 1.02-1.11; $P = .004$) reliably predicted stroke or death at 90 days.**

Conclusions: **This study suggests that previous or simultaneous CEA in patients with unilateral severe asymptomatic carotid stenosis undergoing CABG could prevent stroke better than delayed CEA, without increasing the overall surgical risk. (J Vasc Surg 2011;54:993-9.)**

Patients who are candidates for coronary artery bypass grafting (CABG) have a 3% to 10% incidence of associated significant carotid artery stenosis. In this setting, patients presenting with a unilateral carotid artery stenosis of 80% to 99% carry an increased risk of stroke of about 4%.[1-7] Even if the first report of combined carotid endarterectomy (CEA) and CABG dates from 1972,[8] we still lack evidence on whether prophylactic CEA before or combined with CABG significantly lowers the stroke rate.

Contrary to reports showing the efficacy and safety of prophylactic CEA before CABG,[9-14] some authors have questioned the validity of preventive carotid artery revascularization, suggesting that CEA in patients with asymptomatic carotid stenosis does not significantly lower the rate of ischemic stroke after CABG.[15-18] These conflicting results are probably related to the heterogeneity of the patients enrolled, especially the degree of carotid stenosis, and to the details of the coronary revascularizations performed. This randomized study tested the hypothesis that in patients with asymptomatic carotid artery stenosis >70% undergoing CABG, CEA before or combined with CABG would prevent stroke better than delayed CEA, without increasing the overall risk of surgery.

MATERIALS AND METHODS

Study design. This randomized study was conducted at one academic surgical center and one affiliated hospital. The Institutional Review Board of the University of Rome approved the trial protocol, and all patients provided writ-

From the "Francesco Durante" Department of Surgery, University of Rome "La Sapienza," Rome[a]; the Department of Vascular Surgery, University of Poitiers, Poitiers[b]; and the Department of Cardiovascular Surgery, University of Rome "La Sapienza," Rome.[c]

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Reprint requests: Giulio Illuminati, MD, Via Vincenzo Bellini 14, 00198 Rome, and Italy (e-mail: giulio.illuminati@uniroma1.it).

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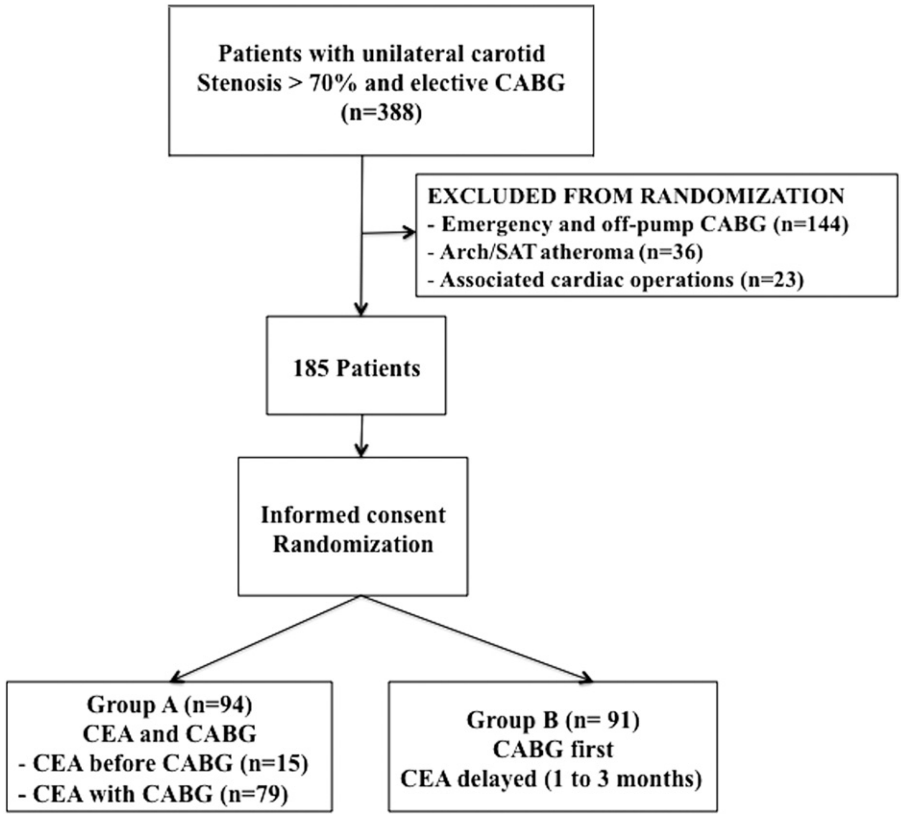

Fig. Flow chart of the study also shows the inclusion and exclusion criteria. *CABG,* Coronary artery bypass graft; *CEA,* carotid endarterectomy; *SAT,* supra-aortic trunks.

ten informed consent. Random assignment of patients to the treatment groups was done independently of participating centers in a one-to-one ratio. The randomization sequence was generated by a computer program and supplied to centers using sealed envelopes generated in blocks of six.

Selection of patients. All of the patients enrolled in the study met the criteria for elective CABG for triple-vessel or left main trunk symptomatic coronary artery disease (CAD) associated with unilateral, asymptomatic carotid stenosis >70% on preoperative color duplex ultrasound scans, and with the absence of significant atherosclerotic disease of the ascending aorta, aortic arch, and supra-aortic trunks at helical computed tomography (CT) scan. The specific criteria to define a stenosis >70% were a peak systolic velocity >250 cm/s at duplex ultrasound imaging, confirmed at CT scan, according to North American Symptomatic Carotid Endarterectomy (NASCET) methodology.[19]

Because many strokes in conjunction with on-pump CABG are probably caused by atheromatous embolization from the ascending aorta, identifying and excluding patients with atheromatous disease of the ascending aorta, aortic arch, and supra-aortic trunks by CT scanning was considered for all patients in this study to focus strictly on the potential risk of associated carotid disease. Helical CT scan was also systematically performed to confirm carotid artery stenosis and indication for CEA as well as to assess the status of intracranial circulation. Significant atherosclerotic disease of the ascending aorta, aortic arch, and supra-aortic trunks was defined as any thrombus-lined lesion from the aortic valve to the ostium of the left common carotid artery, regardless of its diameter, extension, or calcium content.

The study excluded patients undergoing urgent CABG, defined as any revascularization performed outside normal operating hours or displacing other patients from the surgical schedule. Also excluded were patients undergoing CABG with intra-aortic balloon pump, off-pump CABG, or other associated cardiac operations such as valvuloplasty or valvular replacement.

After determination of eligibility for the trial (Fig), patients were randomly assigned to undergo prophylactic CEA before CABG or CEA combined with CABG (group A), the timing of CEA being at the surgeon's preference, or CABG first, followed by CEA ≤3 months later (group B). No patient was excluded from the study due to surgeon's preference or patient refusal.

All patients received oral statin treatment with atorvastatin (20 mg/d) for at least a week before their operation, and all patients received low-molecular-weight heparin in the perioperative period and aspirin (100 mg/d) beginning 1 week after CABG.

Study end points. The primary end point of the study was the overall stroke/mortality rate in the 90 days after CEA or CABG. The trial was specifically designed to extend this primary end point beyond the classic 30 postoperative days to have a longer period in which to include the results of delayed CEA in group B. An ischemic stroke was defined as any neurologic damage lasting >24 hours occurring after CEA or ≤90 days after CABG. Morbidity was recorded, including the occurrence of cervical hematoma after CEA.

Follow-up and statistical analysis. All patients were monitored for 90 days after CABG. The study was designed with a power of 80% to detect differences in primary outcome in 90 patients per group, with a two-sided α risk of 0.05, on the basis of a 5% difference in the incidence of postoperative stroke after CABG alone compared with patients receiving CEA first or combined with CABG. Continuous data were compared using the *t* test, and proportions were compared using χ^2 and the Fischer exact test where appropriate.

A discriminant analysis was performed with "stroke and death at 90 days" as the discriminant variable. After this analysis, predictor variables significantly associated with a postoperative stroke or with a value of $P < .10$ were entered in a logistic regression model with calculation of the *P* value and the odds ratio (OR) with 95% confidence intervals (CIs). Differences between the two groups were considered statistically significant at values of $P < .05$. All calculations were done using SPSS 19 software (SPSS Inc, Chicago, Ill).

RESULTS

From January 2004 to December 2009, the study enrolled 184 of 388 initially eligible patients (Fig). No patient was excluded due to surgeon's preference or patient refusal. During the same period, 3294 CABG were performed. Among the 185 enrolled patients, 94 were randomized to undergo CEA a few days before CABG or CEA combined with CABG (group A), and 91 underwent CEA 1 to 3 months after CABG (group B). No significant differences between the two groups were observed for demographic variables or risk factors (Table I), and indications for CABG were also evenly distributed. In group A, 15 patients (16%) underwent CEA with a median time of 6 days before CABG (range, 5-11 days), whereas 79 patients (84%) underwent CEA combined with CABG. All of the patients in this group underwent CEA under general anesthesia and with the systematic use of a carotid shunt. The surgical technique consisted of a standard CEA via a longitudinal arteriotomy closed on a Dacron patch (Intervascular, La Ciotat, France). Cervical drainage was routinely left in place and removed 1 to 3 days after surgery.

The patients in group B underwent CEA under general anesthesia, with systematic carotid shunting, and the same surgical technique as patients in group A. The details of CABG, including left ventricular ejection fraction as measured by transthoracic echocardiogram, mean duration of cardiopulmonary bypass (CPB), mean number of coronary artery bypass grafts, and rate of redo CABG in both groups are reported in Table I. Patients in group A had a significantly shorter mean duration of CPB than those in group B, respectively 85 ± 16 vs 90 ± 15 minutes ($P = .03$). Postoperative atrial fibrillation occurred in 26 patients (28%) in group A and in 23 patients (26%) in group B, which had resolved in all but two patients in group A and in three patients in group B by the time of hospital discharge.

Combined stroke and mortality rate. Postoperative mortality was 1.0% in group A and 1.1% in group B ($P = .98$). The combined 90-day stroke and death rate was 1.0% (one of 94) in group A [CI 95%] and 9.0% (eight of 91) in group B ($P = .02$), OR, 0.11 [95% CI, 0.01-0.91]. Two patients (one in each group) died of heart failure in the postoperative period. As reported in Table II, the rate of ipsilateral ischemic stroke was 0% in group A and 7.7% (n =

Table I. Patient characteristics

Characteristics	*Group A (n = 94)*	*Group B (n = 91)*	P
Age, years	67 ± 7	66 ± 6	.37
Men	59 (62.8)	61 (67.0)	.54
Hypertension	76 (80.9)	71 (78.0)	.63
Smokers	45 (47.9)	47 (51.6)	.60
Hyperlipidemia	26 (27.7)	30 (33.0)	.43
Diabetes	25 (26.6)	21 (23.1)	.58
COPD	36 (38.3)	38 (41.8)	.63
Lower limb occlusive disease	13 (13.8)	11 (12.1)	.72
Chronic renal insufficiency[b]	3 (3.2)	4 (4.4)	.66
MI > 24 hours	24 (25.5)	19 (20.9)	.45
Stable angina	33 (35.1)	36 (39.6)	
Unstable angina	54 (57.4)	47 (52.6)	.72
Effort dyspnea (%)	7 (7.4)	8 (8.8)	
Mean preoperative LVEF	35.6 ± 5.7	39.2 ± 6.0	.21
Mean duration of CPB, minutes	85.0 ± 16.9	90.3 ± 15.8	.03
Grafts per patient	3.05 ± 0.37	3.02 ± 0.34	.42
Patients with redo CABG	5	4	.77

CABG, Coronary artery bypass grafting; *COPD,* chronic obstructive pulmonary disease; *CPB,* cardiopulmonary bypass; *LVEF,* left ventricular ejection fraction; *MI,* myocardial infarction.
[a]Continuous data are presented as mean ± standard deviation; categoric data as number (%).
[b]Defined as serum creatinine level >125 mmol/L.

Table II. Postoperative stroke, death, and cervical hematoma by univariate analysis

Variable	*Group A n = 94 No. (%)*	*Group B n = 91 No. (%)*	P
Operative mortality	1 (1.0)	1 (1.1)	.98
All strokes[a]	0 (0.0)	7 (7.7)	.008
90-day combined stroke/death[b]	1 (1.0)	8 (8.8)	.018
Post-op cervical hematoma	2 (2.1)	0 (0.0)	.16

[a]Relative risk, 0.92 (95% confidence interval, 0.87-0.97); number needed to treat to avoid a stroke = 13.
[b]Relative risk, 0.92 (95% confidence interval, 0.86-0.98), number needed to treat = 12.9.

Table III. Group B: Details concerning the 90-day strokes[a]

Pt.	*Timing*	*CPB duration (minutes)*	*Severity*	*Outcome*	*Time*
1	Post-op	125	Hemiparesis	Recovery	2 months
2	Post-op	70	Monoparesis	Recovery	2 weeks
3	Post-op	90	Hemiparesis	Persistent	4 weeks
4	39 days	80	Aphasia, hemiparesis	Partial recovery	6 months
5	50 days	110	Aphasia, monoparesis	Partial recovery	3 months
6	58 days	60	Hemiparesis	Partial recovery	2 months
7	66 days	135	Monoparesis	Recovery	3 months

CPB, Cardiopulmonary bypass.
[a]All strokes were ipsilateral hemispheric strokes.

Table IV. Logistic regression analysis with variables in the equation

Step I[a]	$\beta \pm SE$[b]	*Wald*[c]	*df*	P	*OR (95% CI)*
CPB, minutes	0.064 ± 0.022	8.225	1	.004	1.067 (1.021–1.115)
LVEF	−0.005 ± 0.073	.004	1	.948	0.995 (0.862-1.149)
Groups	2.654 ± 1.210	4.812	1	.028	14.205 (1.327-152.099)
MI	1.796 ± 0.965	3.464	1	.063	6.025 (0.909-39.934)
Constant	−11.817 ± 4.380	7.280	1	.007	.000

CI, Confidence interval; *CPB,* cardiopulmonary bypass; *LVEF,* left ventricular ejection fraction; *MI,* myocardial infarction; *OR,* odds ratio; *SE,* standard error.
[a]Variables entered on step I are CPB, LVEF, groups, and MI.
[b]Coefficients and the SE for each predictor variable in the model. The negative coefficient for LVEF indicates the odds of stroke and death decline with increasing LVEF.
[c]Wald statistic and associated *P* values indicate how useful each predictor variable is. In this case, only CPB and groups are significant. Odds ratio less than 1 indicate that an increase in the value of the predictor variable is associated with a decrease in the odds of the event (stroke and death). The 95% CI indicate the magnitude of the association (SPSS 19 software; SPSS Inc, Chicago, Ill).

7) in group B ($P = .008$) [relative risk, 0.92, with 95% CI, 0.87-0.97; number treated to avoid stroke = 13].

In group B, all the strokes were ischemic and ipsilateral. Three occurred during CABG and four at 39, 50, 58 and 66 days, respectively, after CABG. In these four patients, CEA had been delayed while waiting for a sternal dehiscence to heal in one patient and for completion of a prolonged cardiovascular rehabilitation in the other three patients. None of the postoperative strokes occurred in patients who sustained postoperative atrial fibrillation, and no stroke, either hemorrhagic or contralateral to the carotid stenosis, was observed in the entire study cohort. The main features of the observed strokes are detailed in Table III. Two patients (2.1%) in group A presented with a postoperative cervical hematoma, but no postoperative hematoma was observed in group B ($P = .16$; Table II).

The overall mortality and stroke rates for all patients with CABG performed during the study period, but outside the trial, were 2.3% and 1.1%, respectively. Among the 36 patients with unilateral carotid stenosis, but excluded from the trial because of arch atheroma, three (8.3%) sustained a postoperative stroke (two ipsilateral and one contralateral).

Discriminant and logistic regression analysis. Discriminant analysis was performed with "stroke and death at 90 days" as the discriminant variable and left ventricular ejection fraction (LVEF), duration of CPB, previous myocardial infarction (MI), and group as predictor variables. Univariate analysis of variation of 185 cases revealed that the patients who died or sustained a stroke, compared with patients with no complications, differed significantly on three of these four predictor variables: MI, duration of CPB, and group. A single discriminant function was calculated and was significantly different for patients with or without stroke ($\chi^2 = 33.0$, df = 4, $P < .005$). The correlation between predictor variables and the discriminant function suggested that duration of CPB and group were the best predictors of postoperative stroke and death. Overall, the discriminant function successfully predicted outcome for 85.9% of the 185 patients.

A logistic regression analysis was performed with the same discriminant and predictor variables. A total of 185 cases were analyzed and the full model significantly predicted "stroke or death" status (omnibus $\chi^2 = 26.9$, df = 4, $P < .005$). Overall, 95.7% of predictions were accurate. Table IV gives coefficients and the Wald statistics for each of the predictor variables. This shows that only duration of CPB (OR, 1.06; 95% CI, 1.02-1.11; $P = .004$) and delayed CEA (OR, 14.2; 95% CI, 1.33-152.0; $P = .03$) reliably predicted postoperative death or stroke at 90 days.

DISCUSSION

This study shows that CEA before CABG or combined with CABG can prevent stroke better in patients with an asymptomatic carotid artery stenosis >70% undergoing CABG than delayed CEA, without increasing the overall complication rate of surgery. This finding concerns only a selected group of patients undergoing nonurgent CABG without off-pump revascularization or associated cardiac procedures. These selection criteria were decided so that we could compare two homogeneous groups of patients. In addition, the study period was extended to 90 days after CABG so that any neurologic or life-threatening events occurring between 30 and 90 days after CABG or delayed CEA could be considered. The absence of any contralateral stroke in this series is probably due to the exclusion of patients with arch atheroma.

Our results are in agreement with other series reporting that CEA, combined with CABG or preceding CABG, can be performed safely.[9-14] Two population-based reports gave contradictory results; however, Brown et al[20] calculated a combined stroke/mortality rate of 17.7% for 226 simultaneous CEA and CABG procedures performed in 10 states in a 1-year period (1995 to 1996), and Timaran et al[21] recently found a stroke/mortality rate of 8.6% for combined procedures in a United States national survey extending from 2000 to 2004.

Other studies have questioned the validity of this approach, arguing that the risk of postoperative stroke related to asymptomatic carotid stenosis was minimal compared with the overall neurologic risk of CABG. They suggest that CEA does not significantly lower the stroke rate of cardiac surgery.[15-18,22] All of these studies, however, consisted of meta-analyses of small or retrospective series, with all their limitations.[11] Naylor et al,[15] in a comprehensive review of 8972 patients undergoing (1) synchronous revascularization, (2) staged CEA followed by CABG, or (3) reversed-staged CABG, followed by CEA, reported a risk of death or stroke after each procedure of 8.7%, 6.1%, and 7.3%, respectively. The differences did not reach statistical significance. Furthermore, the authors observed that there was significant variability in reporting events between studies with consequent heterogeneity among the compared groups.[15]

After this meta-analysis, two recent reports found no significant increase in the incidence of stroke during CABG or other cardiac operations in patients who presented with asymptomatic carotid stenosis and did not receive prophylactic or combined CEA.[16,17] However, these studies included <100 patients with a follow-up that did not exceed 30 days in one of the studies[17] and with a significant number of patients with off-pump CABG or other associated cardiac operations. In addition, neither of these two studies actually addressed the issue of management of the carotid stenosis that was not operated on.

One additional retrospective study[23] commented specifically on the risk of stroke in patients with bilateral carotid stenosis who undergo CABG in the presence of an unoperated-on contralateral carotid stenosis. The authors reported good overall results of the combined procedure, without any stroke related to the nonoperated-on carotid artery, thus challenging the assumption that carotid disease was an important cause of stroke during cardiac surgery. However, this retrospective study included among the nonoperated-on group a wide range of carotid stenoses of 50% to 99%. When considering the 32 patients in this study with asymptomatic carotid stenoses >70%, who were considered for CEA, the incidence of postoperative stroke on the nonoperated-on site was 2.7%, which is not negligible. If only a 30-day period had been used, the present study would not have reached a significant end point.

However, our main purpose was to study the potential effect of delayed CEA, considering that the course of CABG may exceed 30 postoperative days, which then forces the delayed CEA. We emphasize that the fate of patients with a significant—but untreated—carotid stenosis >30-day time limit has seldom been considered in the current meta-analyses. The results of this study, with a 90-day surveillance period, significantly support the value of CEA, before or combined with CABG, as a better prevention of stroke, compared with delayed CEA after CABG.

Apart from carotid stenosis, the occurrence of atrial fibrillation has also been related to stroke after CABG in 4.6% to 36.5% of patients.[24,25] In this randomized trial, the percentage of patients with atrial fibrillation was comparable in both groups, and none of the strokes occurred in patients with postoperative atrial fibrillation. Atheromatous embolization from a diseased ascending aorta or aortic arch at the time of aortic manipulation or cannulation during CABG may also be responsible for postoperative stroke in patients after CABG.[18,26,27] Out analyses of the literature found that atherosclerosis of the ascending aorta and aortic arch was rarely systematically investigated in patients scheduled for CABG. In our series, however, all patients with significant disease of the ascending aorta or the aortic arch were excluded to avoid a confounding factor in relation to embolic strokes due to aortic atherosclerosis, and this probably limits the external applicability of this study.

Finally, multivariate analysis in this study showed that the duration of CPB was an additional risk factor for postoperative stroke and death, despite an overall difference in CPB duration between the two groups of only 5 minutes. Aside from the statistical result, we do not believe that a difference of 5 minutes is clinically relevant. Nonetheless, among other factors, the correlation between the percentage of carotid artery stenosis and the reduction of cerebral perfusion during CPB is known.[28] Duration of CPB, as a marker of depressed cardiac function and overall reduced cerebral perfusion, may be a predictor of a poorer surgical outcome, particularly in case of an exceedingly long CPB time. This finding underscores the usefulness of prior or combined CEA in the prevention of stroke, especially whenever lengthy CPB is anticipated during CABG. In this study, we observed a 5% stroke rate during the first 90 days after CABG, whereas the predicted 5-year ipsilateral stroke rate in patients with an asymptomatic carotid stenosis is ~11%. We have no sound explanation for this finding but speculate that symptomatic coronary lesions are a marker of severe atheromatous disease and explain the risk of asymptomatic carotid artery stenosis in this setting.

CONCLUSIONS

Our study has shown that in patients who are candidates for nonurgent CABG who have unilateral severe and asymptomatic carotid artery stenosis, prophylactic or synchronous CEA could offer a better protection from ischemic stroke than delayed CEA. These results underline the importance of a systematic search for significant carotid stenosis in all patients who are candidates for CABG.

AUTHOR CONTRIBUTIONS

Conception and design: GI, JBR, FC, MAP, GF, FaM, FrM, MT
Analysis and interpretation: GI, JBR, FC, GF, FaM, FrM, MT
Data collection: FC, MAP
Writing the article: GI, JBR
Critical revision of the article: GI, JBR, FC, MAP, GF, FaM, FrM, MT
Final approval of the article: GI, JBR, FC, MAP, GF, FaM, FrM, MT
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DISCUSSION

Dr Richard Cambria (*Boston, Mass*). Congratulations on a great study. And as Rob mentioned, all of the studies over the past 30 years, save one that Norm Hertzer conducted, now 30 years ago, have not been randomized in a way that yours has.

Dr Ricotta, in back of me, has been pleading for a randomized study. My own feeling is that it's such a pleasure to comment on this study because it reinforces or is consistent with the position that we've taken on this problem really for the past 30 years. We've published a couple of large series of combined carotid and CABG operations. And fundamentally, our posture has been that if a patient has a carotid stenosis that you would otherwise fix if they walked into the office and they happened to be in need of a coronary bypass, we fix the lesions simultaneously.

So I think that your data are very important, most important in that it shows that patients with a critical carotid stenosis who come through a CABG are at risk in that postoperative period as they recover, as they are prothrombotic and so forth, and I was very interested to see that all of the strokes occurred ipsilateral to the carotid lesion but not as a complication of a delayed carotid endarterectomy. So I think that this is a very important study. I would encourage you to get it right into the *Journal of Vascular Surgery* because I am sure it will have great appeal for publication.

And I have just one question: in your Group A, how did you decide which patients got a promontory carotid endarterectomy versus a combined procedure?

Dr Giulio Illuminati. The decision was left to the cardiac surgeon's choice. There are cardiac surgeons in our group who prefer the carotid endarterectomy to be done first; others agree that it be done simultaneously.

Dr Cambria. And I think it's important and I'm going to take from your answer that vascular surgeons performed all the carotid operations, because I have a strong feeling that some of the poor results in the literature reported with this operation are a function of the fact that the cardiac surgeon did both of the operations.

Dr Illuminati. In this series all carotid endarterectomies were performed by vascular surgeons.

Dr John J. Ricotta (*Washington, DC*). That was a very nicely presented study and I congratulate you. You've been able to do something that, as Dr Cambria said, only Norm Hertzer has been able to do before.

I think it's important to make a couple of points. You have excellent results, better than most of the results in the literature, and I think that's because of your patient selection; no aortic atheroma, no emergency coronary bypass, no complicated cardiac procedures. And that was a good thing for you to do because it allowed you to focus on the exact issue of the role of the carotid.

I'd like you just to answer two questions, because they're going to come up from people who do not believe that this is indicated. One is, were there any patients who – you had a very small group of precarotid followed by CABG, or pre-endarterectomy then CABG – but were there any patients in who you planned to do a staged procedure in whom you did not do the staged procedure because of a complication following their carotid endarterectomy? I think it needs to be clear whether there were any patients that you planned to randomize that were excluded.

Dr Illuminati. No, there were not. The 15 patients who underwent carotid endarterectomy prior to coronary artery bypass grafting had an uneventful postoperative course and were operated of coronary artery bypass grafting with a week delay on the average.

Dr Ricotta. The second question is the severity of the carotid stenosis. I understand that you looked at 70% and higher. Do you have any idea how many of these patients had truly very severe carotid stenosis? Because, again, if you operate on patients with moderate carotid stenosis, as have a number of other studies, you're not going to get a benefit. So, I think it's very important for you in the manuscript to try to outline the severe stenosis. You have a very high postoperative stroke rate. Other people have not seen that. I think it's because of the severity of the stenosis in your patients.

Dr Illuminati. About 80% of the patients had a stenosis of the carotid artery which was over 80%. One of the patients who presented with a late stroke actually thrombosed his previously severely stenotic carotid artery.

Dr Ricotta. Again, I would put that in the manuscript because I think they're very important points in patient selection.

Dr Munier M. Nazzal (*Toledo, Ohio*). I have three small questions. The first one is did you have any recurrent stenosis, asymptomatic stenosis, or they were primary?

Dr Illuminati. No, they were all primary stenoses. Redo carotid endarterectomies have been excluded from this study.

Dr Nazzal. And the other thing is any of those patients who are asymptomatic had any stroke before 6 months, so what's your definition of asymptomatic?

Dr Illuminati. A carotid artery stenosis is defined asymptomatic in a patient who has not, in his global history, any evidence of either ischemic attack or fixed stroke.

Dr Nazzal. And from this study, how do you extrapolate on patients who have severe asymptomatic bilateral carotid stenosis?

Dr Illuminati. They were studied systematically with preoperative duplex ultrasound. However, for the purposes of this study, bilateral, severe carotid stenoses, were excluded.

Dr Peter F. Lawrence (*Los Angeles, Calif*). A publication 10 to 15 years ago looked at discharge diagnoses from our National Inpatient Survey and showed that patients who had a CPT code for carotid endarterectomy and a coronary artery bypass as a simultaneous procedure had nearly a 25% incidence of stroke. That seemed to be the real world practice at that time. Do you think that the much better results presented here today will be translated to the everyday practice of carotid surgery?

Dr Illuminati. The poor results of this survey are probably partially related to the fact that patients were not stratified for their risk. Such survey included also patients undergoing urgent coronary artery revascularization. We did not randomize such patients in this study. In addition, for patients referred to high volume centers with experience in carotid surgery, results tend to be better compared to those of the general community. This is a case for centralization of practice.