Editorials
Treatment of patients with concomitant coronary and carotid lesions

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Since atherosclerosis is a generalized degenerative process, a concomitant involvement of different vascular territories is not surprising.

The coexistence of carotid artery disease in patients with coronary artery stenosis who are potential candidates for coronary artery bypass grafting (CABG) is not uncommon.

Risk factors such as diabetes, arterial hypertension, hyperlipidemia and smoking, are often present in patients with combined coronary and carotid disease. Furthermore, patients with carotid artery disease undergoing CABG are older and much more likely to have peripheral vascular disease than those without concomitant carotid disease. Besides, more advanced heart disease (a higher incidence of left main coronary artery stenosis and a reduced ejection fraction) is generally observed in patients with combined disease[1,2].

Due to all the above, patients with severe coexistent carotid and coronary atherosclerosis represent a difficult, high-risk population, and the optimal method of management is controversial.

Incidence of carotid disease in coronary artery bypass graft patients

The incidence of carotid disease in patients who are candidates for CABG varies from 2 to 22%[1-6]. This wide variation is related to the definition of significant carotid artery disease, to the methods of screening, and to the frequency of their use. For practical purposes, it is imperative to identify those patients with their carotid disease necessitating surgical treatment according to well established guidelines based on prospective randomized trials[7-9]. Carotid endarterectomy (CEA) clearly appears to be beneficial for symptomatic and asymptomatic patients with severe (at least 70%) carotid stenosis. The surgical benefit is obviously remarkably higher when neurological symptoms are present and the stenosis is > 80% or bilateral.

Extrapolating data from studies designed to determine the surgical indications in isolated carotid disease is perhaps not entirely appropriate in managing patients with combined carotid and coronary disease who definitely have a different risk profile. In the absence of specific scientific information, however, it is reasonable to extend the guidelines for isolated carotid disease to patients with concomitant carotid and coronary disease.

Nowadays the presence and the severity of carotid disease is mostly assessed noninvasively by ultrasonic carotid artery duplex scanning. According to Roederer et al.[10], this method yields a sensitivity of 99% and a specificity of 84% when compared with conventional angiographic studies.

Wareing et al.[11] found that 4.1% of CABG patients had ≥ 80% carotid stenosis as systematically measured by duplex scanning. CABG patients in whom a carotid artery bruit is detected at physical examination have a much higher probability of significant carotid disease[12]. The incidence of carotid disease in CABG patients also appears to increase with age, as documented by Faggioli et al.[13] who report that 8.7% of CABG patients aged ≥ 60 years have a > 75% carotid stenosis.

D'Agostino et al.[14] report age, diabetes, smoking, a left main coronary lesion, prior

stroke or transient ischemic attack, and prior vascular operation as clinical predictors of significant carotid disease. In view of the cost-benefit ratio of a screening program, in our Institution ultrasound evaluation of the carotid arteries in CABG patients is carried out only when at least one of the criteria listed in table I is present.

Natural history and surgical risk

The prognosis of patients with concomitant carotid and coronary disease is unfavorably influenced by the fact that the brain and heart are both at risk for serious ischemic events (stroke and myocardial infarction) which may be fatal. The frequent association of diabetes, arterial hypertension and other risk factors for atherosclerosis plays a role in further worsening the prognosis. As far as the surgical risk is concerned, certainly the presence of severe atherosclerotic disease in one part of the circulation influences the risk of surgical treatment directed to another territory.

In patients who undergo CABG and in whom carotid artery disease is not present, the perioperative stroke rate is rather low (< 2%)[15]. The stroke rate increases considerably in the presence of significant carotid artery disease. According to Faggioli et al.[13], the odds ratio for stroke after CABG is 9.9 when a carotid stenosis > 75% is documented. The risk of perioperative stroke after CABG is further increased in the presence of significant bilateral carotid disease or when a previous neurologic event occurred[16]. Although the mechanism of perioperative neurologic events after heart surgery is multifactorial, evidence suggests that a critical (flow and pressure limiting) carotid stenosis is a possible cause of perioperative stroke. As a matter of fact, during cardiopulmonary bypass, the cerebral autoregulation is disordered and the cerebral blood flow is directly proportional to the cerebral perfusion pressure. Besides, the risk of perioperative myocardial infarction in patients submitted to isolated CEA is not negligible and may reach 4%[17]. Moreover, in the experience of the Cleveland Clinic, 70% of the late deaths following successful CEA could be attributed to coronary artery disease[18].

These data suggest that the candidates to CEA should be appropriately evaluated to rule out significant coronary artery disease.

Table I. Criteria used for ultrasound evaluation of the carotid arteries in coronary artery bypass graft patients.

Age > 65 years
Detection of carotid artery bruit
Prior stroke or transient ischemic attack
Presence of risk factors (diabetes, heavy smoking, hypertension, hyperlipidemia)
Peripheral vascular disease

Conventional surgical strategies

Selecting the optimal surgical approach for patients with combined carotid and coronary disease is crucial in order to decrease the risk of stroke and myocardial infarction in the perioperative period.

Conventional surgical strategies can range from a staged procedure (CEA first and CABG second) or a reversed staged procedure (CABG first and CEA second) to a simultaneous CEA and CABG procedure during one anesthesia.

In patients who are submitted to a staged procedure, the surgical technique for carotid and coronary revascularization is not different from the conventional procedure in the single vascular territory. In patients who undergo concomitant carotid and coronary revascularization, CEA is performed first in normothermia before the beginning of the extracorporeal circulation. CABG is carried out immediately after the institution of the cardiopulmonary bypass during cardioplegic arrest of the heart.

The choice of the surgical approach should be individualized, taking into account the severity of the obstructing lesions in the two vascular territories and the related symptoms. In general, when CEA is performed first and CABG later (staged procedure) the overall perioperative stroke rate seems to be slightly reduced, while the rate of myocardial infarction is somewhat increased[13,19-22]. Conversely, when CABG is carried out first followed by CEA later (reversed staged procedure), the overall perioperative stroke rate is consistently increased while the rate of myocardial infarction declines[19-21].

The simultaneous procedure is the preferred therapeutic approach when the obstructing lesions are equally severe in the two vascular territories and when symptoms (cardiac and neurological) are present. The results obtained with the simultaneous procedure in a number of large series are illustrated in table II[22-27]. Our own experience at the San Raffaele University Hospital is presented in table III.

In the clinical context under consideration, performing the procedure in one stage is certainly attractive and convenient, regardless of the point of view. To eliminate the waiting period between the two operations is undoubtedly beneficial since the persistence of severe obstructing atherosclerotic lesions in one vascular territory is potentially dangerous. Furthermore, the advantages of a single procedure (one anesthesia, one hospitalization) in terms of the allocation of resources and hospital costs are obvious[28]. The operative risk as well as the complication rate, however, is not negligible, but this is mainly related to the high-risk profile of the population of patients who are candidates for the simultaneous procedure.

Alternative treatment modalities

Obstructive coronary and carotid atherosclerotic lesions can be also treated percutaneously in the catheter-

Table II. Results of simultaneous carotid endarterectomy and coronary revascularization (series including > 100 patients).

Author	No. patients	Mortality (%)	MI (%)	Stroke (%)
Reul et al.[22]	143	4.2	–	2.8
Akins et al.[23]	200	3.5	2.5	3
Vermeulen et al.[24]	230	3.5	1.7	6.1
Halpin et al.[25]	133	1.5	4.5	2.3
Minami et al.[26]	114	1.8	0	4.4
Chang et al.[27]	206	2	–	2.3

MI = myocardial infarction.

Table III. Simultaneous carotid endarterectomy and coronary revascularization at the San Raffaele University Hospital (1997-2002).

No. patients	133
Hospital mortality	7 (5.2%)*
Stroke	1 (0.7%)
Transient ischemic attack	1 (0.7%)

* multiorgan failure 4 patients, low cardiac output 3 patients.

ization laboratory. In addition, a surgical myocardial revascularization procedure can be performed, without resorting to an extracorporeal circulation, on a beating heart using stabilizers and other appropriate *ad hoc* devices.

If the outcome is to be optimized, when dealing with patients who often present with many incremental risk factors for operative mortality and morbidity great flexibility is required in using the entire spectrum of the available therapeutic options.

Off-pump coronary revascularization. Surgical coronary revascularization can be also carried out on a beating heart without cardiopulmonary bypass. This approach has been shown to be associated with more favorable results, particularly in old patients with comorbidities and in patients with left ventricular dysfunction[29,30]. In the presence of obstructive carotid disease the extracorporeal circulation which abolishes the autoregulation of the cerebral blood flow and produces some degree of cerebral edema, might be detrimental. Another argument in favor of the beating heart technique is that cannulation and clamping of the aorta (in patients with carotid disease often severely compromised by atherosclerotic changes) can be avoided.

Percutaneous transluminal coronary angioplasty. Obstructive coronary lesions can also be effectively treated by percutaneous transluminal coronary angioplasty (PTCA) and stenting. This treatment modality is not commonly used in patients with coexistent carotid disease due to the extension and complexity of the lesions in the coronary arterial tree (high prevalence of left main stem lesions, triple vessel disease, multiple and extensive atherosclerotic plaques, total occlusion of important branches). Occasionally, however, the percutaneous approach can be conveniently applied, particularly when unstable angina is the predominant clinical problem and a culprit lesion can be identified. Similarly, some patients with an extremely high-risk profile could benefit from PTCA and stenting of the coronary arteries.

Carotid stenting. Although the first percutaneous procedure was carried out more than 20 years ago, only recently, due to advances in technology and to the rapid evolution of stenting devices, have large series of patients with carotid disease been treated with carotid stenting. The success rate of this treatment modality is high and the complication rate is low. The occurrence of restenosis is infrequent and the mid-term results are encouraging. In our Institution, since 1998, 155 patients have been treated with percutaneous carotid angioplasty/stenting. The in-hospital stroke rate was 0.6% whereas the incidence of transitory ischemic attacks was 5.1%. The mid-term mortality due to cerebral vascular accidents was 1.3% (2/155) and the incidence of restenosis 2.3%. Carotid stenting has been used in emergency situations with resolution of the acute neurologic symptoms. More data, however, have to be accumulated if the role of this approach in such a context is to be further clarified. The number of patients who were submitted to concomitant carotid stenting and PTCA is very small and no conclusion can be drawn so far.

The "individualized" approach

Only the results with conventional surgical strategies have been extensively reported in the literature. Experiences with other treatment modalities are rather scanty, and consistent data regarding the outcome of patients with coexistent carotid and coronary disease treated with carotid stenting combined with PTCA or off-pump CABG are not yet available. Therefore, the idea of considering the entire armamentarium of the possible therapeutic options for a tailored approach to the individual patient is not supported by sound scien-

tific information but is only recommended by common sense. Patients with concomitant carotid and coronary disease present with a large variety of clinical and anatomical pictures. They are usually older and sicker than patients with isolated carotid and coronary disease, have more risk factors and consequently more comorbidity. Under these circumstances, the strategy of treatment should be individually selected to minimize the trauma, to eliminate unnecessary risks and to optimize the outcome.

In figure 1 all the possible therapeutic modalities which can be combined as indicated are illustrated.

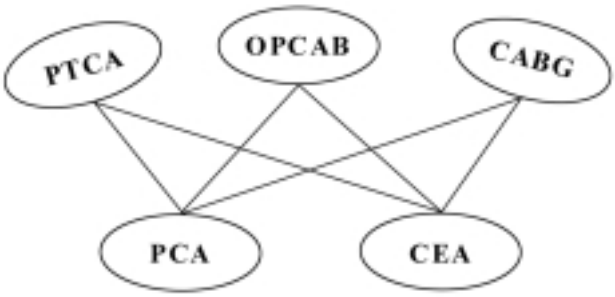

Figure 1. *Current treatment modalities for concomitant carotid and coronary artery disease. CABG = coronary artery bypass graft; CEA = carotid endarterectomy; OPCAB = off-pump coronary artery bypass; PCA = percutaneous carotid angioplasty; PTCA = percutaneous transluminal coronary angioplasty.*

Conclusion

Due to population aging, the proportion of patients with coexisting carotid and coronary disease requiring treatment is on the increase.

The conventional treatment consists of CEA and CABG performed either concomitantly or following a two-step procedure (staged approach). Due to the high-risk profile of the patients, the mortality and morbidity of the conventional surgical treatment are not negligible.

Alternative less invasive treatment modalities (off-pump CABG, PTCA, carotid stenting) should also be explored and selectively considered as part of the armamentarium of the therapeutic options for this difficult group of patients.

An "individualized" approach is recommended in order to minimize the risks and improve the overall results.

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