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CLINICAL RESEARCH

Assessment of carotid artery stenosis before coronary artery bypass surgery. Is it always necessary?

Évaluation des sténoses carotidiennes avant chirurgie de pontages coronaires.
Est-ce toujours utile ?

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Summary

Background. – Extracranial internal carotid artery stenosis is a risk factor for perioperative stroke in patients undergoing coronary artery bypass surgery (CAB). Although selective and non-selective methods of preoperative carotid screening have been advocated, it remains unclear if this screening is clinically relevant.

Aim. – To test whether selective carotid screening is as effective as non-selective screening in detecting significant carotid disease.

Abbreviations: CAB, Coronary artery bypass surgery; CEA, Carotid endarterectomy; CI, Confidence interval; CVD, Cerebrovascular disease; PVD, Peripheral vascular disease.

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Methods. – The case records of patients consecutively undergoing CAB were reviewed. Patients were stratified retrospectively into high- or low-risk groups according to risk factors for significant carotid stenosis and perioperative stroke: peripheral vascular disease (PVD), carotid bruit, diabetes mellitus, age >70 years and/or history of cerebrovascular disease. Prevalence of carotid stenosis detected by ultrasonography, surgical management and perioperative stroke rates were determined in each group.

Results. – Overall, 205 consecutive patients underwent preoperative carotid screening. The prevalence of significant carotid stenosis was 5.8%. Univariate analysis confirmed that PVD ($P=0.005$), carotid bruit ($P=0.003$) and diabetes mellitus ($P=0.05$) were significant risk factors for stenosis. Carotid stenosis was a risk factor for stroke ($P=0.03$). Prevalence of carotid stenosis was higher in the high-risk group (9.1%) than the low-risk group (1.2%) ($P<0.05$). All concomitant or staged carotid endarterectomies/CAB (5/205) and all patients who had perioperative strokes (5/205) were in the high-risk group ($P=0.01$).

Conclusion. – In our cohort, selective screening of patients aged >70 years, with carotid bruit, a history of cerebrovascular disease, diabetes mellitus or PVD would have reduced the screening load by 40%, with trivial impact on surgical management or neurological outcomes.

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MOTS CLÉS

Coronaropathie ;
Pontage coronaire ;
Athérosclérose
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AVC

Résumé

Objectifs. – Les sténoses de l'artère carotide interne sont un facteur de risque d'accident vasculaire cérébral (AVC) chez les patients bénéficiant d'une chirurgie coronaire. Faut-il pour autant dépister ces sténoses chez tous les patients ou une sélection est-elle judicieuse ?

Méthodes. – Les dossiers des patients ayant bénéficié de pontages coronaires ont été revus. Ces patients ont été rétrospectivement classés en « haut » et « bas » risque d'AVC en fonction des facteurs de risque identifiés dans la littérature. La prévalence des sténoses carotidiennes au doppler, ses conséquences sur le management des patients et le taux d'AVC périopératoire étaient déterminés dans chaque groupe.

Résultats. – Deux cent cinq patients consécutifs ont bénéficié de l'évaluation carotidienne préopératoire par échodoppler. La prévalence des sténoses carotidiennes significatives au doppler était de 5,8%. L'analyse univariée a confirmé que l'AOMI ($p=0,005$), le souffle carotidien ($p=0,003$) et le diabète ($p=0,005$) étaient des facteurs de risque significatifs de sténose. La sténose carotidienne était un facteur de risque d'AVC ($p=0,003$). La prévalence des sténoses était supérieure dans le groupe à « haut » risque (9,1% contre 1,2% ; $p=0,05$). Tous les patients ayant bénéficié d'un geste sur les carotides avant ou pendant la chirurgie coronarienne (5/205) et tous les patients ayant souffert d'un AVC (5/205) étaient dans le groupe à « haut » risque indépendamment du fait qu'ils aient une sténose ou pas ($p=0,01$).

Conclusion. – Dans notre série, le dépistage sélectif chez les patients de plus de 70 ans, ayant un souffle carotidien, un antécédent cérébrovasculaire, un diabète ou une AOMI aurait réduit le nombre d'échodoppler de 40% quasiment sans impact sur la prise en charge et les AVC.

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Background

Perioperative stroke is one of the major complications of coronary artery bypass surgery (CAB), with a reported incidence of 2.1–5.2% [1,2] and a related mortality of 0–38% [3,4]. Significant extracranial internal carotid artery stenosis (i.e. $\geq 70\%$ luminal narrowing) is a well-established risk factor for perioperative stroke in patients undergoing CAB [5–7]. To prevent this serious complication, carotid endarterectomy (CEA) has been recommended in patients undergoing CAB in a staged or concomitant approach; CEA/CAB studies have been conducted since the 1970s [8,9]. Although the benefits of CEA/CAB remain uncertain, some of these studies reported reductions in stroke rates, prompting the notion that preoperative screening for carotid stenosis in all CAB patients is necessary to reduce perioperative and long-term stroke rates [10,11]. Such systematic,

non-selective carotid screening does, however, add considerable time and expense to preoperative workups.

Alternatively, some investigators have identified risk factors for carotid disease that could be used for more selective screening. These risk factors include older age [12,13], carotid bruit [14,15], previous neurological event [14,15], previous carotid surgery [15], peripheral vascular disease (PVD) [15], hypertension, diabetes, dyslipidaemia and smoking [12]. Unfortunately, there are neither consensus criteria to provide guidelines for centres looking to optimize their carotid screening practices nor prospective management outcome studies.

In the present study, we sought to report the results of our single-centre routine experience in non-selective preoperative carotid screening of CAB patients over a 5-year period. Our hypothesis was that selective carotid screening is as effective as non-selective screening in detecting significant

carotid stenosis and does not result in higher perioperative stroke rates. We also studied whether selective screening would result in significant changes in surgical management.

Materials and methods

Patient selection

We retrospectively reviewed the files of all consecutive patients undergoing isolated de novo CAB from January 2003 to December 2008, who fulfilled the necessary criteria. Inclusion criteria were: patients undergoing CAB with no other concomitant cardiac procedure (such as valve replacement/repair, aneurysmectomy, atrial septal defect closure); carotid screening by ultrasonography performed exclusively in our centre; and assessment of carotid bruit by at least one of the senior physicians in our department. Exclusion criteria were: aortic stenosis even if not significant (bruit of aortic stenosis can hide a carotid bruit); need for emergency surgery; and carotid evaluation performed in another centre.

Data collection

Prespecified preoperative, operative and postoperative clinical data were extracted independently by two investigators (D.L.S., J.-C.C.) from all patients' charts using a standardized form. Information discrepancies were resolved by consensus or by retrieving further information from additional medical records. Preoperative variables included demographic data, smoking status, diabetes mellitus diagnosed as a documented history of diabetes or use of any antidiabetic medication, hypertension, history of previous stroke, carotid bruit, cerebrovascular disease (CVD) and PVD. Patients were considered as having PVD if they had intermittent claudication, a history of peripheral revascularization or duplex ultrasound showing significant arterial stenosis.

Evaluation of internal carotid stenosis was performed with duplex ultrasound. The degree of stenosis was expressed as the percentage of luminal narrowing estimated by ipsilateral internal common carotid artery flow velocity ratios (duplex ultrasound). Carotid artery stenosis was considered "significant" when there was $\geq 70\%$ luminal narrowing of the affected internal carotid artery, which was determined by duplex ultrasonography in accordance with widely accepted clinical guidelines. In our institution, CEA is considered if carotid stenosis is $>70\%$ in asymptomatic patients; surgery is decided on a case-by-case basis [5,6,16].

Postoperative data were extracted from a neurological assessment/outcome database initiated at our centre to prospectively monitor the neurological progress and clinical outcomes of all patients after cardiac surgery. These data were collected on a daily basis and included death and stroke ratios. A cerebral vascular accident or "stroke" was defined as an acute neurological event resulting from cerebral circulatory impairment and lasting >24 hours. The outcome of postoperative stroke was defined as the clinical diagnosis of stroke and confirmed by brain imaging (head computed tomography, magnetic resonance imaging or both). A transient ischaemic attack was

defined as a temporary neurological deficit attributable to circulatory impairment and lasting <24 hours. Mortality was defined as any death occurring during the same hospital stay.

Operative technique

All patients underwent median sternotomy. The anaesthetic technique was standardized and consisted of low-to-intermediate doses of narcotics, inhalational agents and paralytics. Cardiopulmonary bypass was performed with myocardial protection achieved by antegrade and/or retrograde cardioplegia and topical hypothermia. Cardiotomy suction was routinely returned to the cardiopulmonary bypass circuit. Off-pump CAB was performed according to surgeon preference.

When performed concomitantly with CAB, CEA was completed before sternotomy. Using uniform operative techniques, vascular surgeons from the division of vascular surgery conducted each endarterectomy. Partial heparinization, common to internal carotid intraluminal shunting and, when indicated, patch carotid arteriotomy closure, were used in each case.

Risk stratification

In our cohort, according to previously established risk factors for stroke [12–15], patients with at least one of the following features were retrospectively stratified into the high-risk group: patients with either CVD or PVD, diabetes mellitus, carotid bruit and/or aged >70 years. Patients without any of these risk factors were included in the low-risk group. We determined the prevalence of significant carotid stenosis, the number of CEAs performed and the number of perioperative strokes in the high-risk and low-risk groups. We retrospectively applied the screening algorithm (high-risk and low-risk groups) to our cohort of CAB patients who underwent routine carotid screening and then determined the prevalence of carotid stenosis in each group. Finally, the predictive value of the selective screening strategy based upon these risk factors was estimated.

Statistical analysis

Preoperative, operative and postoperative outcome data were reviewed. Continuous and dichotomous variables were compared using Student's *t* test and the Chi² test, respectively. Fisher's exact test was used for comparisons in which at least one cell value was <5 . All probabilities were two-tailed with $P < 0.05$ regarded as significant. Statistical analysis was performed using the SPSS statistical software package (SPSS Inc., Chicago, IL, USA).

Results

Univariate risk factor analysis

We included 205 patients in the study group. Among these patients, 12 (5.8%) had significant carotid stenosis, unilateral in all cases. Univariate analysis confirmed, in accordance with the literature, that PVD ($P = 0.005$),

Table 1 Results of univariate analysis of risk factors for significant carotid stenosis ($\geq 70\%$ luminal narrowing).

Risk factor	$\geq 70\%$ stenosis (<i>n</i> = 12; 5.9%)	<70% stenosis (<i>n</i> = 193; 93.7%)	<i>P</i>
Men (<i>n</i>)	11	167	
Women (<i>n</i>)	1	26	1.0
Hypertension	7 (58)	104 (54)	1.0
Diabetes mellitus	5 (42)	36 (19)	0.05
Dyslipidaemia	10 (83)	142 (74)	0.7
Body mass index >25	9 (75)	141 (73)	1.0
History of CVA	2 (17)	9 (5)	0.1
History of PVD	5 (42)	18 (9)	0.005
Carotid bruit heard	5 (42)	15 (8)	0.003
Smoking	8 (67)	127 (66)	1.0

CVA: cerebrovascular accident; PVD: peripheral vascular disease.
Data are number (%) unless otherwise indicated.

diabetes mellitus ($P=0.05$) and carotid bruit ($P=0.003$) are risk factors for significant carotid stenosis (Table 1).

Outcomes in patients with or without carotid stenosis

Among the 12 patients with significant carotid stenosis, two (16.7%) had a stroke. Both strokes were ipsilateral to the carotid stenosis but in one case, the carotid artery was 100% occluded before cardiac surgery. Among the 193 patients without significant carotid stenosis, only three (1.6%) had a stroke ($P=0.03$). The perioperative death rate was 0/12 (0%) in the group of patients with significant carotid artery stenosis and 3/193 (1.6%) in the group of patients without significant carotid artery stenosis (P =not significant).

Selective screening algorithm

Applying our selective screening algorithm (high-risk and low-risk groups) to the 205 screened patients, 121 were included in the high-risk group and 84 in the low-risk group (Fig. 1).

Among the high-risk patients, 11 (9%) had significant carotid stenosis and two (18.2%), in whom screening detected significant carotid stenosis, had perioperative strokes. High-risk patients with significant carotid stenosis who underwent staged or combined CEA/CAB did not have a lower stroke rate than those who underwent CAB alone (1/6 patients vs 1/5 patients, respectively). In terms of overall stroke rates, 4.1% of high-risk patients with carotid stenosis had perioperative strokes compared with none among low-risk patients with carotid stenosis. CEA/CAB was performed in 4.1% of high-risk patients compared with no low-risk patients screened (5/121 patients vs 0/84 patients, $p=0.08$).

We found that significant carotid stenosis was more prevalent in the high-risk group (9.1% vs 1.2% in the low-risk group; $p=0.03$) and that selective screening had a specificity of 92% (95% confidence interval [CI], 65–99%) and a sensitivity of 43% (95% CI, 36–50%) to detect significant stenosis, and a sensitivity of 100% (95% CI, 57–100%) and a

specificity of 58% (95% CI, 51–65%) to predict perioperative stroke.

The main results are summarized in Table 2.

Among the 84 low-risk patients, only one (1.2%; 95% CI, 0.2–6.4%) demonstrated significant carotid stenosis. None of these 84 patients had a perioperative stroke (0%; 95% CI, 0.0–4.4%). Among the low-risk patients, no patient underwent CEA/CAB.

All of the patients who had perioperative strokes (two with significant carotid stenosis and three without) were in the high-risk group, with a trend for a statistically significant difference between the two groups (0/84 patients vs 5/121 patients; $p=0.08$).

Discussion

We retrospectively reviewed the files of 205 consecutive patients undergoing isolated de novo CAB. According to previously established risk factors for stroke, we retrospectively stratified patients who underwent carotid screening into a high-risk or low-risk group. Five patients (2.4%) had perioperative strokes; among these, two had significant carotid stenosis but three did not, and the main result of this study is that all of these five patients were incorporated into the high-risk group. None of the low-risk patients had a perioperative stroke.

Unlike other serious complications associated with CAB, such as haemorrhage, infection and myocardial infarction, stroke represents an often irreversible, lifelong and debilitating complication that counteracts the benefits of coronary revascularization. Because significant carotid stenosis is a well-recognized risk factor for stroke, particularly in CAB patients, our team has adopted routine, non-selective, preoperative, carotid screening over the past several years. Given that such screening is supported by a grade IIa (level of evidence: C) recommendation [16], we aimed to critically evaluate this practice by testing the hypothesis that selective carotid screening was as effective as non-selective screening in detecting significant carotid disease without resulting in a higher perioperative stroke rate.

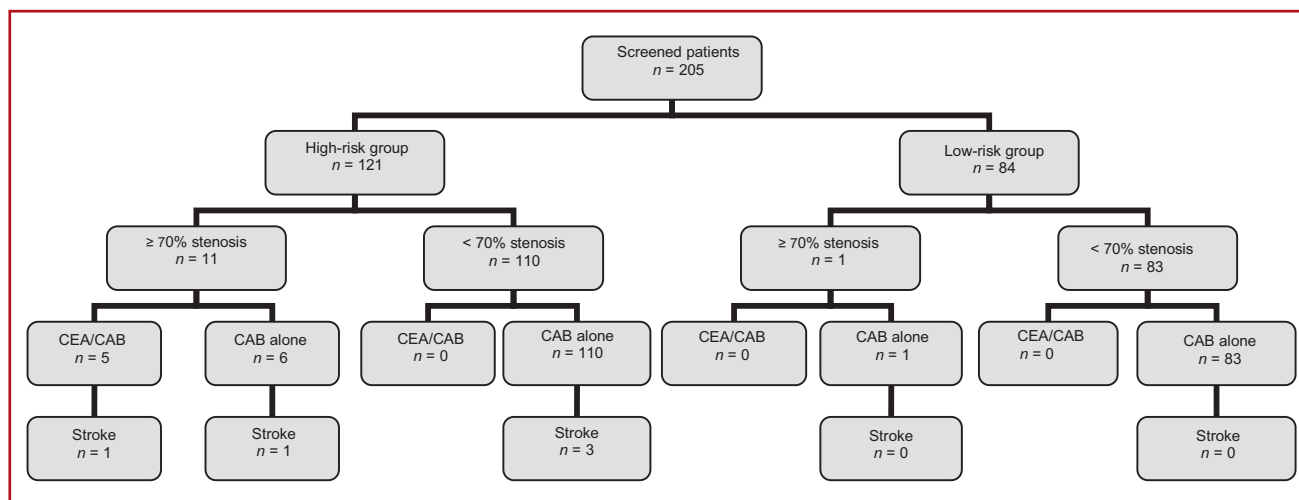


Figure 1. Outcome summary for the 205 patients who underwent preoperative screening. Outcomes for high-risk and low-risk patients grouped according to the presence or absence of $\geq 70\%$ carotid stenosis and/or carotid endarterectomy (CEA) are shown. CAB: coronary artery bypass surgery.

Table 2 Main results according to risk status.

	All patients (n = 205)	High-risk patients (n = 121)	Low-risk patients (n = 84)	p
$\geq 70\%$ stenosis	12 (5.8)	11 (9.1)	1 (1.2)	0.03
Stroke	5 (2.4)	5 (4.1)	0 (0)	0.08

Data are number (%).

Prevalence of significant carotid stenosis in CAB patients

The prevalence of significant carotid stenosis in the 205 patients who underwent routine carotid screening was 5.8%. This percentage is in accordance with previously published studies, which have reported a prevalence of strokes between 1.7 and 22% [17,18] in CAB patients. This wide range is explained by dissimilarities in the definition of "significant" stenosis, methods of screening and patient inclusion or exclusion criteria.

Risk factors for carotid stenosis

The univariate analysis of patients included in our series who underwent carotid screening supports the recognized risk factors associated with carotid stenosis. These risk factors included carotid bruit [15], diabetes mellitus [12] and PVD [14,19]. The statistically most significant risk factors for carotid stenosis in our study were PVD and carotid bruit.

Carotid stenosis as a risk factor for stroke

As expected and in accordance with previous studies [16], significant carotid stenosis was associated with higher perioperative stroke, confirming it as a risk factor for this complication in CAB patients. Among the 12 patients with significant carotid stenosis, two (16.7%) had a stroke. Both

strokes were ipsilateral to the carotid stenosis but in one case, the carotid artery was 100% occluded before cardiac surgery. Occlusion is usually considered as a less dangerous lesion than severe stenosis. This is an important point because there is a wide range of mechanisms of stroke in patients undergoing a coronary artery bypass graft (atrial fibrillation, emboli from the arch, etc.) and, obviously, we cannot be sure that the carotid occlusion was responsible for the stroke.

Basis of selective carotid screening algorithm

We adopted a simple screening algorithm based upon five of the most prominent risk factors for carotid stenosis substantiated by the literature and, for three of them, confirmed by our univariate analysis: history of CVD or PVD, carotid bruit, diabetes mellitus and age >70 years. There are, of course, many other risk factors for carotid stenosis but we selected these because they appeared to be prominent, clinically relevant and, therefore, easy to recognise in the preoperative stage in candidates for CAD. Patients with symptomatic CVD are not only more likely to have $\geq 70\%$ carotid stenosis, but those with carotid stenosis benefit more from CEA than their asymptomatic counterparts in terms of 5-year stroke reduction [5,20]. Carotid bruit is a marker of turbulent flow secondary to carotid stenosis; in our cohort, 25% of CAB patients with a bruit also had $\geq 70\%$ carotid stenosis. Finally, advanced age has been reported to increase the association

between carotid disease and perioperative stroke in CAB. Faggioli et al. found that CAB patients aged >60 years with >75% carotid stenosis had a stroke rate of 15% [13].

Selective versus routine carotid screening in detecting significant carotid stenosis

Of the 205 patients who underwent carotid screening, five (2.4%) patients had perioperative strokes. Of these five, two had significant carotid stenosis, confirming that significant carotid stenosis is a risk factor for stroke (16.7% vs 1.6%; $p=0.03$) (Table 2) but three patients had no significant carotid artery stenosis, confirming that degree of stenosis is not the only predictive stroke factor.

We applied our screening algorithm retrospectively to our cohort of CAB patients who underwent routine carotid screening, stratifying them into high-risk and low-risk groups. A selective approach towards screening only high-risk patients would have allowed us to screen only 59% of our cohort with very good outcome. None of the low-risk patients underwent CEA and none had a perioperative stroke. These data support the first component of our hypothesis: selective carotid screening is similar to non-selective screening in terms of detecting significant and high-risk carotid stenosis. Moreover, carotid stenosis is not the only risk factor for stroke (others being atrial fibrillation, etc.) [7].

Outcome analysis of selective versus routine carotid screening

We performed an analysis of the impact that selective screening would have had on patient outcome by retrospectively examining the surgical management and perioperative stroke rates of the high-risk versus low-risk groups among the 205 patients who underwent carotid screening (Fig. 1). Our selective screening approach would have identified, as high risk, all five patients who ultimately had perioperative strokes. These data suggest that patients classified as low risk derived negligible benefit from routine carotid screening, in terms of affecting surgical management or neurological outcomes. Furthermore, the fact that routine carotid screening of all low-risk patients over 5 years in a busy clinical cardiac surgery department revealed only one patient with significant carotid stenosis, suggests that this practice is relatively unproductive.

The perioperative stroke rate was not lower in high-risk patients who underwent CAB/CEA (1/5 patients; 20%) compared with those who did not (1/6 patients; 16.7%), although the low number of patients precludes any firm conclusion.

In summary, patients aged <70 years without a history of CVD or PVD and no carotid bruit and no diabetes mellitus have a lower risk of having significant carotid stenosis and of having a perioperative stroke during CAB. We observed no stroke in low-risk patients attributable to significant carotid stenosis. Taken together, these results support the second component of our hypothesis: that selective carotid screening does not result in higher perioperative stroke rates. In a review on this topic in 2009, Aboyans and Lacroix suggested that a history of CVD or PVD and older age are

factors associated with higher probability of carotid stenosis and can help to improve the risk-benefit ratio of the screening strategy [21].

Conclusion

The results of this retrospective study support the hypothesis that selective carotid screening is a valuable alternative to systematic screening as it does not lead to higher perioperative stroke rates. Screening only patients with a history of CVD or PVD, carotid bruit, diabetes mellitus and/or aged >70 years could reduce the screening load by approximately 40%, with a negligible impact on surgical management (i.e. CEA/CAB) and neurological outcomes. These data support the initiation of prospective studies to validate these cost-effective selective screening practices.

Conflicts of interest statement

None.

References

- [1] D'Ancona G, Saez de Ibarra JI, Baillet R, et al. Determinants of stroke after coronary artery bypass grafting. *Eur J Cardiothorac Surg* 2003;24:552–6.
- [2] McKhann GM, Goldsborough MA, Borowicz Jr LM, et al. Predictors of stroke risk in coronary artery bypass patients. *Ann Thorac Surg* 1997;63:516–21.
- [3] McKhann GM, Grega MA, Borowicz Jr LM, et al. Encephalopathy and stroke after coronary artery bypass grafting: incidence, consequences, and prediction. *Arch Neurol* 2002;59:1422–8.
- [4] Salazar JD, Wityk RJ, Grega MA, et al. Stroke after cardiac surgery: short- and long-term outcomes. *Ann Thorac Surg* 2001;72:1195–201 [discussion 201–2].
- [5] North American symptomatic carotid endarterectomy trial collaborators. Beneficial effect of carotid endarterectomy in symptomatic patients with high-grade carotid stenosis. *N Engl J Med* 1991;325:445–53.
- [6] European carotid surgery trialists' collaborative group. MRC European carotid surgery trial: interim results for symptomatic patients with severe (70–99%) or with mild (0–29%) carotid stenosis. *Lancet* 1991;337:1235–43.
- [7] Naylor AR, Mehta Z, Rothwell PM, et al. Carotid artery disease and stroke during coronary artery bypass: a critical review of the literature. *Eur J Vasc Endovasc Surg* 2002;23:283–94.
- [8] Bernhard VM, Johnson WD, Peterson JJ. Carotid artery stenosis. Association with surgery for coronary artery disease. *Arch Surg* 1972;105:837–40.
- [9] Naylor AR, Cuffe RL, Rothwell PM, et al. A systematic review of outcomes following staged and synchronous carotid endarterectomy and coronary artery bypass. *Eur J Vasc Endovasc Surg* 2003;25:380–9.
- [10] Archbold RA, Barakat K, Magee P, et al. Screening for carotid artery disease before cardiac surgery: is current clinical practice evidence based? *Clin Cardiol* 2001;24:26–32.
- [11] Fukuda I, Gomi S, Watanabe K, et al. Carotid and aortic screening for coronary artery bypass grafting. *Ann Thorac Surg* 2000;70:2034–9.
- [12] Ascher E, Hingorani A, Yorkovich W, et al. Routine preoperative carotid duplex scanning in patients undergoing open heart surgery: is it worthwhile? *Ann Vasc Surg* 2001;15:669–78.

- [13] Faggioli GL, Curl GR, Ricotta JJ. The role of carotid screening before coronary artery bypass. *J Vasc Surg* 1990;12:724–9 [discussion 29–31].
- [14] Hill AB, Obrand D, Steinmetz OK. The utility of selective screening for carotid stenosis in cardiac surgery patients. *J Cardiovasc Surg (Torino)* 1999;40:829–36.
- [15] Walker WA, Harvey WR, Gaschen JR, et al. Is routine carotid screening for coronary surgery needed? *Am Surg* 1996;62:308–10.
- [16] Eagle KA, Guyton RA, Davidoff R, et al. ACC/AHA 2004 guideline update for coronary artery bypass graft surgery: a report of the American college of cardiology/American heart association task force on Practice Guidelines (Committee to update the 1999 Guidelines for coronary artery bypass graft surgery). *Circulation* 2004;110:e340–437.
- [17] Cosgrove DM, Hertzner NR, Loop FD. Surgical management of synchronous carotid and coronary artery disease. *J Vasc Surg* 1986;3:690–2.
- [18] Schwartz LB, Bridgman AH, Kieffer RW, et al. Asymptomatic carotid artery stenosis and stroke in patients undergoing cardiopulmonary bypass. *J Vasc Surg* 1995;21:146–53.
- [19] Salasidis GC, Latter DA, Steinmetz OK, et al. Carotid artery duplex scanning in preoperative assessment for coronary artery revascularization: the association between peripheral vascular disease, carotid artery stenosis, and stroke. *J Vasc Surg* 1995;21:154–60 [discussion 61–2].
- [20] Walker MD, Marler JR, Goldstein M, et al. Endarterectomy for asymptomatic carotid artery stenosis. Executive committee for the Asymptomatic Carotid Atherosclerosis Study. *JAMA* 1995;273:1421–8.
- [21] Aboyans V, Lacroix P. Indications for carotid screening in patients with coronary artery disease. *Presse Med* 2009;38:977–86.