

Does preoperative carotid stenosis screening reduce perioperative stroke in patients undergoing coronary artery bypass grafting?

Khalil Masabni, MD,^a Sajjad Raza, MD,^a Eugene H. Blackstone, MD,^{a,b} Heather L. Gornik, MD,^c and Joseph F. Sabik III, MD^a

ABSTRACT

A number of institutions routinely perform carotid artery ultrasound screening before coronary artery bypass grafting (CABG) to identify carotid artery disease requiring revascularization before or during CABG, with the expectation of reducing perioperative neurologic events. The assumptions are that carotid disease is causally related to perioperative stroke and that prophylactic carotid revascularization decreases the risk of post-CABG neurologic events. Although carotid artery stenosis is a known risk factor for perioperative stroke in patients undergoing CABG, it might be a surrogate marker for diffuse atherosclerotic disease rather than a direct etiologic factor. Moreover, the benefit of prophylactic carotid revascularization in patients with asymptomatic unilateral carotid disease is uncertain. Therefore, we have reviewed the literature for evidence that preoperative carotid artery screening, by identifying patients with significant carotid artery stenosis and altering their management, reduces perioperative neurologic events in those undergoing CABG. (*J Thorac Cardiovasc Surg* 2015;149:1253-60)



Carotid artery duplex ultrasound.

Central Message

A number of institutions routinely perform carotid artery ultrasound screening before coronary artery bypass grafting, with the expectation of decreasing perioperative neurologic events. However, carotid artery stenosis might simply be a surrogate marker for diffuse atherosclerotic disease, and the benefit of prophylactic carotid revascularization in asymptomatic patients with unilateral carotid disease is uncertain.

Author's Perspective

A number of institutions routinely perform carotid artery ultrasound screening before coronary artery bypass grafting (CABG) to identify carotid artery disease that necessitates revascularization before or during CABG, with the expectation of reducing perioperative neurologic events. However, among patients undergoing CABG, clinical variables alone can identify those who have significant carotid artery disease, with as high a degree of sensitivity as ultrasound. Moreover, carotid duplex ultrasound screening, whether selective or nonselective, identifies only a minority of patients who will develop perioperative stroke, and intervening for those with carotid disease might not decrease the risk of these neurologic events.

From the Department of Thoracic and Cardiovascular Surgery,^a Heart and Vascular Institute; Department of Quantitative Health Sciences,^b Research Institute; and Department of Vascular Medicine,^c Heart and Vascular Institute, Cleveland Clinic, Cleveland, Ohio.

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Address for reprints: Joseph F. Sabik III, MD, Department of Thoracic and Cardiovascular Surgery, Cleveland Clinic, 9500 Euclid Ave/Desk J4-1, Cleveland, OH 44195 (E-mail: sabikj@ccf.org).

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Abbreviation and Acronym

CABG = coronary artery bypass grafting

Stroke is a devastating complication of coronary artery bypass grafting (CABG).¹ For this reason, a number of institutions routinely screen patients undergoing CABG (Table 1)²⁻⁷ for severe carotid artery stenosis and potential carotid revascularization, with the expectation of reducing the risk of post-CABG stroke. This practice is contrary to guidelines recommending screening in selected patients only.^{8,9} The underlying assumptions are that carotid disease is causally related to perioperative stroke and that prophylactic carotid revascularization decreases its risk. However, if carotid artery stenosis is not a direct etiologic risk factor for perioperative stroke, routine nonselective screening may not be cost effective.^{4,10} In addition, the benefit of prophylactic carotid revascularization in patients with asymptomatic unilateral carotid disease is controversial.¹¹⁻¹⁵ Therefore, we have reviewed the literature for evidence that preoperative carotid artery screening, by identifying patients with substantial carotid stenosis and altering their management, decreases perioperative neurologic events in patients undergoing CABG.

PERIOPERATIVE STROKE IN PATIENTS UNDERGOING CABG

Stroke is a serious complication of CABG that occurs in 1.3% to 2.0% of patients^{1,16-18} and results in acute mortality of up to 38%.^{19,20} The cause of post-CABG stroke is multifactorial, but because most strokes occur ≥ 24 hours after surgery, embolic events are the most likely culprits.^{15,21-24} Macroembolization of atherothrombotic debris from the severely atherosclerotic aorta is strongly associated with postoperative stroke.^{16,25-27} Shedding of emboli to the brain might be caused by manipulation of the ascending aorta during aortic clamping, cannulation, and proximal graft anastomosis.^{23,28,29} Dislodging of emboli from the heart due to manipulation by the surgeon or atrial fibrillation are other possible causes.³⁰ Intraoperative hemodynamic abnormalities, such as hypotension during cardiopulmonary bypass, and pulmonary diastolic hypertension after cardiopulmonary bypass, are also associated with increased risk of post-CABG stroke.³¹ Microembolization of platelet aggregates and turbulent blood flow during cardiopulmonary bypass are other possible causes.^{28,32} In addition, atherosclerotic disease of the cerebral arteries is an important mechanism of stroke in patients undergoing CABG.⁷

Risk factors for perioperative stroke include older age, prior stroke or transient ischemic attack, peripheral artery disease, hypertension, left ventricular dysfunction, preoperative atrial fibrillation,^{1,25,28,33-36} and carotid artery stenosis.^{11,24,28,34,37} A carotid bruit has been found to be a preoperative predictor of severe aortic arch atheroma.³⁸ Therefore, some consider carotid artery disease to be an epiphenomenon, serving as a marker for diffuse systemic atherosclerotic disease, rather than being a causal factor.^{10,12,39,40} Data from Cleveland Clinic patients undergoing noncardiac surgery demonstrated no association between carotid artery stenosis and stroke (odds ratio 1.0, with a 95% confidence interval of 0.99-1.02) for a 10-unit increase in internal carotid artery peak systolic velocity, the variable used to quantify carotid artery stenosis.⁴¹

POSSIBLE MECHANISMS BY WHICH CAROTID ARTERY STENOSIS COULD LEAD TO PERIOPERATIVE STROKE

It is thought that carotid intraplaque hemorrhage can result in plaque destabilization⁴²⁻⁴⁶ and intimal ulceration, creating a nidus for thromboembolism.⁴⁷⁻⁵² Intraplaque hemorrhage detected by magnetic resonance imaging is associated with increased risk of ipsilateral stroke in symptomatic and asymptomatic nonsurgical patients^{53,54} and is strongly related to onset of symptoms.⁵⁵ We hypothesize that anticoagulating patients during CABG might be responsible for increased intraoperative risk of intraplaque hemorrhage. Mechanical causes can trigger intraplaque hemorrhage as well, such as turbulent blood flow and hypertension, both of which can occur during cardiac surgery.⁵⁵

Impaired cerebral hemodynamic function distal to carotid artery stenosis is another determinant of postoperative stroke.^{22,56} Maximally dilated vessels distal to carotid artery stenosis can no longer vasodilate in response to hemodynamic compromise. Therefore, perioperative reduction in blood pressure or cardiac output in this group of patients is hypothesized to lead to cerebral ischemia.^{40,56} Moreover, reduced cerebral blood flow might result in decreased washout of microemboli in patients undergoing CABG.⁵⁷

DETECTING CAROTID ARTERY DISEASE

Carotid artery duplex ultrasound, which is used to visualize plaque and measure flow velocity to quantify stenosis, is the screening test usually used to identify patients with carotid artery stenosis (see Central Image).⁵⁸ The sensitivity of carotid ultrasound to detect carotid artery stenosis, of $>70\%$ is 86% to 90%, with a specificity of 87% to 94%.⁵⁹ Although ultrasound screening is currently used to determine the degree of carotid artery stenosis, other duplex-determined plaque characteristics are also

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