Original Article

The Prevalence and Severity of Cerebrovascular Disease in Patients Undergoing Cardiovascular Surgery

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Objectives: The degree of preoperative cerebrovascular disease in patients undergoing cardiovascular surgery has not been well studied. Thus, the purpose of this study was to evaluate the prevalence and severity of cerebrovascular disease in such patients.
Methods: The subjects were 91 patients who underwent cardiovascular surgery. We investigated the prevalence and severity of cerebral infarction (CI), intracranial artery stenosis (ICAS) of ≥50%, cervical carotid artery stenosis (CCAS) of ≥50%, and periventricular hyperintensity (PVH) using magnetic resonance imaging (MRI) and magnetic resonance angiography (MRA).
Results: The prevalence of cerebrovascular diseases was: CI, 79 patients (86.8%) [33 had some small infarctions, 38 had multiple small infarctions, eight had broad infarctions greater than 15 mm); ICAS, 17 patients (18.7%)]; CCAS, 30 patients (33.0%) [21 had stenosis of <70%, and nine had stenosis of ≥70% or occlusion]; and PVH, 79 patients (86.8%).
Conclusion: Patients undergoing cardiovascular surgery have a high prevalence of cerebrovascular disease in varying degrees. (Ann Thorac Cardiovasc Surg 2004; 10: 81–4)

Key words: cardiovascular surgery, cerebrovascular disease, neurological complications, magnetic resonance imaging (MRI), magnetic resonance angiography (MRA)

Introduction

Many authors have reported that preoperative cerebrovascular disease is one of the risk factors for postoperative neurological complications.[1-3] However, the prevalence and severity of cerebrovascular disease in patients undergoing cardiovascular surgery, especially valve and thoracic aortic surgery, has not been documented. Recently, there has been an increase in the age of surgical candidates, and one can thus anticipate an increase in the cerebrovascular disease burden. Therefore, there is a need to determine the prevalence and severity of cerebrovascular disease in patients undergoing cardiovascular surgery, and then to decide on the appropriate precautionary measures needed to avoid postoperative neurological complications. There are many ways to evaluate cerebrovascular disease preoperatively, including duplex ultrasonography, brain computed tomography, positron emission tomography, angiography, magnetic resonance imaging (MRI), and magnetic resonance angiography (MRA). Among these, MRI and MRA can be performed simultaneously, and they can reveal both cerebral and cervical artery lesions without the need for any contrast media. We therefore use both MRI and MRA as preoperative screening measures to obtain the appropriate information needed to be able to properly determine the surgical procedure.

The purpose of this study was to investigate, using both MRI and MRA, the prevalence and severity of cerebrovascular disease in consecutive patients undergoing cardiovascular surgery. Furthermore, we assessed the efficacy of MRI and MRA as preoperative screening tools.

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Table 1. Patients characteristics

No. of patients	91
Male	59 (64.8%)
Age (years)	69±12
Hypertension: ≥150 mmHg in systole, ≥90 mmHg in diastole	56 (62.2%)
Diabetes mellitus: HbA1c ≥6%	18 (20%)
Hyperlipidemia: cholesterol ≥200 mg/dl, triglyceride ≥150 mg/dl	25 (27.8%)
Obesity: body mass index ≥25	7 (7.8%)
Peripheral vascular disease: ankle pressure index <0.7	5 (5.6%)
History of cerebral infarction (including transient ischemic attack)	19 (21.1%)
Atrial fibrillation	9 (9.9%)
Coronary artery disease	39 (42.8%)
Heart valve disease	35 (38.4%)
Thoracic aortic aneurysm	17 (18.7%)

Data are presented as numbers (%) of patients or mean values ± standard deviation.

Subjects and Methods

Between December 1, 1999 and December 1, 2002 there were 91 consecutive patients (59 males, 32 females) undergoing cardiovascular surgery. Mean age was 69±12 years. Thirty-nine patients had coronary artery disease (CAD), and 35 had heart valve disease (HVD), and 17 had thoracic aortic aneurysm (TAA). MRI and MRA (Intera 1.5T, Philips Medical Systems, Best, the Netherlands) were performed several days before the surgery as screening for cerebrovascular disease. We evaluated the prevalence of cerebral infarction (CI), intracranial artery stenosis (ICAS) of ≥50%, cervical carotid artery stenosis (CCAS) of ≥50%, and periventricular hyperintensity (PVH). The study variables and their definitions are presented in Table 1.

We investigated the surgical results of these 91 patients and evaluated the efficacy of MRI and MRA as preoperative screening tools to avoid postoperative neurological complications.

Results

The prevalence of cerebrovascular diseases was: CI, 79 patients (86.8%) [33 had some small infarctions (smaller than 15 mm), 38 had multiple small infarctions (smaller than 15 mm), eight had broad infarctions (greater than 15 mm), and among them 60 patients had a silent infarction with neither a history of infarction nor paralysis]; ICAS, 17 patients (18.7%) [nine patients had ICAS with normal visualization of the distal artery, eight had ICAS with poor visualization of the distal artery or occlusion]; CCAS, 30 patients (33.0%) [21 had stenosis of <70%, and, nine had stenosis of ≥70% or occlusion]; PVH, 79 patients (86.8%). The distribution of cerebrovascular disease among all patients is summarized in Fig. 1. The prevalence rates in groups of patients with CAD, HVD, and TAA are separately summarized in Table 2.

Appropriate measures were undertaken to manage the patients who were found to have significant cerebrovascular disease. We performed off-pump coronary artery bypass (OPCAB) for 16 patients who had a broad infarction or severe ICAS with poor visualization of the distal artery. Combined or preceding carotid endarterectomy (CEA) was performed in six patients with a CCAS of ≥70% (three patients underwent combined OPCAB and CEA). Only one patient with a small CI suffered irreversible cerebral ischemia due to postoperative hemodynamic collapse. No neurological complications occurred in the other patients.

Discussion

This study showed that the cerebrovascular disease burden was high in patients undergoing cardiovascular surgery. In particular, 86.8% of patients had CI, 18.7% had ICAS, 33.0% had CCAS, and 86.8% had PVH. The group of patients with HVD had a relatively lower prevalence rate than other groups.

While our study documented a prevalence of 86.8% for CI, Goto et al. reported that 49.6% of coronary artery bypass candidates had a small CI (<15 mm) and 2.6% had broad infarctions.[3] They concluded that multiple or broad infarctions were risk factors for postoperative neurological dysfunction and stroke. In fact, such infarctions were detected in 50.5% of the patients in this study. As a precaution, we performed OPCAB for patients with broad

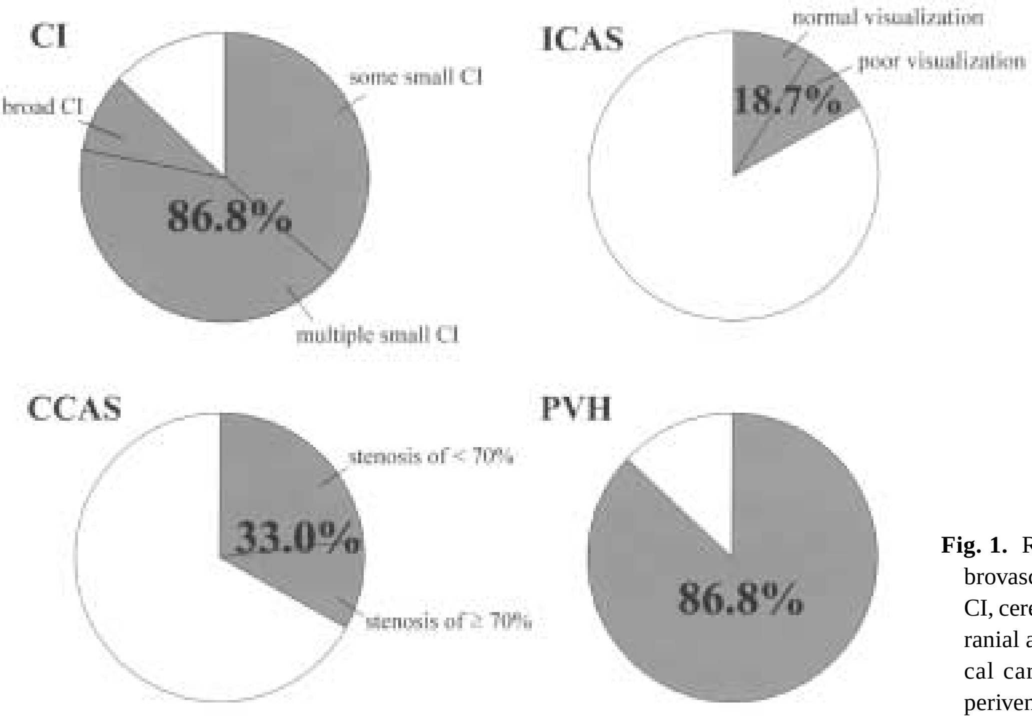

Fig. 1. Rate of patients having cerebrovascular disease.
CI, cerebral infarction; ICAS, intracranial artery stenosis; CCAS, cervical carotid artery stenosis; PVH, periventricular hyperintensity.

Table 2. Prevalence rate (%) of cerebrovascular disease in patients with coronary artery disease, heart valve disease, and thoracic aortic aneurysm

	CI	ICAS	CCAS*	PVH
Coronary artery disease	97.6	25.6	41.2 (15.4)	87.1
Heart valve disease	77.1	11.4	20.0 (2.9)	85.7
Thoracic aortic aneurysm	82.3	17.6	41.1 (11.7)	88.2

CI, cerebral infarction; ICAS, intracranial artery stenosis; CCAS, cervical carotid artery stenosis; PVH, periventricular hyperintensity.
* Parenthetic numbers indicate prevalence rate of patients with CCAS of ≥70%.

CI at a time when OPCAB was not yet a standard operation in our institution.

Seventeen patients (18.7%) had an ICAS of ≥50%. It has been reported that ICAS is much more common in Black and Asian populations than in the Caucasian population.[4] Using MRA, Uehara et al. found that in patients with coronary artery disease (mean age: 60.1 years old), 7.4% had ICAS of ≥50%.[5] Yoon et al. reported that 8.0% of patients who underwent coronary artery bypass (mean age: 51 years old) had an ICAS of ≥50% on MRA and transcranial Doppler, and identified ICAS as a risk factor for neurological complications following coronary artery bypass.[6] We believe that the relatively higher average age of patients in our study was the main reason why the prevalence of ICAS in our study was higher than that of other reports.

MRA might overestimate the degree of stenosis and include a possibility of false positive. Besides, there might be affluent collateral system in some intracranial arteries. Therefore it is important to check both ICAS and visualization of the distal artery. Eight patients (8.8%) had an ICAS with poor visualization of the distal artery or occlusion. As a precaution, we performed OPCAB for such patients. No neurological complications were observed in patients treated in this manner.

We found that the morbidity rate associated with CCAS was 33% (30/91). Given that a CCAS of ≥70% poses an especially high risk of perioperative neurological complications in cardiac surgery, many authors have reported good results with a staged or combined carotid endarterectomy and cardiac surgery.[7-9] The morbidity rate for this degree of CCAS has been reported to be 4.7-12.0%[10-12] and a total of nine patients (9.9%) had a CCAS of ≥70% in this study. Recently, a combined carotid endarterectomy with OPCAB has been suggested as an appropriate procedure.[13] We followed this preventive approach for patients with coronary artery disease and a CCAS of ≥70% and therefore avoided any neurological complications.[14]

In this study, 79 patients had PVH (86.8%). It has been reported that PVH has a relationship with atherosclerosis of the medullary artery, chronic cerebral ischemia, and cognitive dysfunction.[15,16] There are no available reports that deal with the relationship between PVH and cardiovascular surgery. Thus, it still remains necessary to investigate how the long-term outcome of PVH would be affected by cardiovascular surgery or cardiopulmonary bypass.

There are many ways to perform a preoperative evaluation of cerebrovascular disease. At present, the selection of the particular evaluation used depends on the particular institution. One benefit of concurrent MRI and MRA is that this approach can evaluate both cerebral and cervical lesions without using contrast agents. We, therefore, believe that concurrent MRI and MRA offer the best screening capability, especially for patients who have poor renal function. MRI excels at detecting cerebral infarction and its critical time compared to computed tomography. Meanwhile MRA without a contrast agent is inferior to angiography and three-dimensional computed tomography with respect to its resolution and might overestimate the degree of stenosis in a stenotic lesion, since MRA is generated from blood flow. However, such an overestimate is itself not problematic for a preoperative screening test done to rule out cerebrovascular disease. Whenever MRI and MRA done for screening show a suspicious lesion indicating ICAS or CCAS, we add a further examination, such as duplex ultrasonography, single photon emission computed tomography, or angiography, to obtain more accurate information about the suspected lesion. We can then perform cardiovascular surgery having chosen an appropriate strategy based on all the relevant information at hand.

Conclusion

Patients undergoing cardiovascular surgery including coronary artery bypass or other procedures have a high prevalence and severity of cerebrovascular disease. MRI and MRA are useful tools with which to obtain sufficient information so as to be able to formulate an appropriate strategy before proceeding with cardiovascular surgery.

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