Predictors of Diseased Ascending Aorta in Patients Undergoing Off-Pump Coronary Artery Bypass Surgery

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ABSTRACT

Objective. To identify the preoperative risk factors associated with increased prevalence of atherosclerotic lesions of the ascending aorta among patients undergoing off-pump coronary artery bypass surgery (OPCAB).

Material and Methods. OPCAB was performed in 241 patients who were intraoperatively investigated by epiaortic ultrasound for the presence of atherosclerotic lesions of the ascending aorta. The Northern New England Cardiovascular Disease Study Group (NNECVDSG) and the Multicenter Study of Perioperative Ischemia (McSPI) stroke risk scores were retrospectively calculated.

Results. A diseased ascending aorta was detected by intraoperative epiaortic ultrasound in 74 patients (30.7%). Patient's age (P = .002, odds ratio [OR] 1.067, 95% confidence interval [CI] 1.025-1.110), diabetes (P = .023; OR, 2.211; 95% CI, 1.117-4.378), extracardiac arteriopathy (P = .014; OR, 2.567; 95% CI, 1.214-5.428) and urgent/emergency operation (P < .0001; OR, 3.066; 95% CI, 1.685-5.580) were independent preoperative predictors of a diseased ascending aorta. The area under the ROC curve of the NNECVDSG score in predicting a diseased ascending aorta was 0.710 (95% CI, 0.642-0.778), and that of the McSPI score was 0.722 (95% CI, 0.655-0.788). The prevalence of a diseased ascending aorta was 11.2%, 34.7%, and 49.4% among the NNECVDSG score tertiles (P < .0001), and 11.3%, 31.7%, and 49.4% among the McSPI score tertiles (P < .0001).

Conclusions. These findings confirm the reported high incidence of a diseased ascending aorta in patients undergoing coronary artery bypass surgery. Current stroke risk scores, particularly the simple NNECVDSG score, are valuable predictors of increased prevalence of a diseased ascending aorta.

INTRODUCTION

It has been widely demonstrated that a diseased ascending aorta is a main determinant of postoperative stroke after coronary artery bypass surgery [Calafiore 2002; Kapetanakis 2004]. In these patients, the risk of postoperative stroke can be reduced by avoiding manipulation, cannulation, and/or clamping of the ascending aorta as needed. The aim of the present study was to identify the preoperative clinical risk factors associated with the presence of atherosclerotic lesions of the ascending aorta as detected by intraoperative epiaortic ultrasound scanning.

MATERIAL AND METHODS

The records of 241 patients who underwent isolated off-pump coronary artery bypass surgery (OPCAB) from April 2004 to December 2005 were retrospectively reviewed for details regarding the presence of atherosclerotic lesions of the ascending aorta as detected by intraoperative ultrasound scanning. Once clinical data were retrieved, the Northern New England Cardiovascular Disease Study Group (NNECVDSG) [Charlesworth 2003] and the Multicenter Study of Perioperative Ischemia (McSPI) [Newman 1996] stroke risk scores were calculated in all of these patients. Preoperative clinical data and operative data are summarized in Table 1.

Intraoperative epiaortic ultrasound examination was performed by an echocardiographic system (transducer 15-6L, Sonos 5500; Philips, Bothell, WA, USA). A film of gel was placed on the tip of the transducer, which was then placed inside a sterile plastic bag. The ultrasound findings were interpreted by the surgeons and the anesthesiologist. No mapping of the atherosclerotic lesions of the ascending aorta was done. No-touch technique was adopted when the extent of the atherosclerotic disease was such to contraindicate aortic clamping. When appropriate, we used the Heartstring proximal anastomotic device (Guidant, Santa Clara, CA, USA) or the PAS-Port proximal aortic connector device (Cardica, Guidant, Diegem, Belgium). In 3 patients these devices have been used without ultrasonographic evidence of atherosclerotic lesions into the ascending aorta.

Heparin (3.0 mg/kg) was given intravenously after sternotomy to maintain activated clotting time more than

Clinical and Operative Data*

	Non-Diseased Ascending Aorta, 167 Patients	Diseased Ascending Aorta, 74 patients	P
Age, y	66.3 ± 8.3	69.7 ± 6.6	.008
Female patients	42 (25.1%)	15 (20.3%)	.411
Diabetes	31 (18.6%)	23 (31.1%)	.032
Pulmonary disease	11 (6.6%)	11 (14.9%)	.040
Atrial fibrillation	7 (4.2%)	10 (13.5%)	.009
Extracardiac arteriopathy	19 (11.4%)	20 (27.0%)	.002
Stroke	15 (9.0%)	3 (4.1%)	.287
TIA	3 (1.8%)	5 (6.8%)	.060
Neurological dysfunction	14 (8.4%)	4 (5.4%)	.596
Carotid endarterectomy	2 (1.2%)	1 (1.4%)	1.00
Current smoking	24 (14.4%)	13 (17.6%)	.525
Unstable angina pectoris	14 (8.4%)	14 (18.9%)	.019
Urgent/emergency operation	59 (35.3%)	46 (62.2%)	<.0001
Recent myocardial infarction	50 (29.9%)	32 (43.2%)	.044
Previous cardiac surgery	0	0	—
Congestive heart failure	7 (4.2%)	8 (10.8%)	.050
Hypertension	78 (46.7%)	32 (43.2%)	.619
Critical preoperative status	5 (3.0%)	3 (4.1%)	.704
Intra-aortic balloon pump	1 (0.6%)	1 (1.4%)	.521
Ventricular septal rupture	0	0	—
Creatinine, mg/dL	78.3 ± 32.0	85.7 ± 48.7	.095
C-reactive protein, ≥10 mg/dL	35 (21.6%)	27 (37.5%)	.011
Left ventricular ejection fraction <40%	16 (9.6%)	11 (14.9%)	.230
LIMA graft	167 (100%)	73 (98.6%)	.307
RIMA graft	10 (6.0%)	5 (6.8%)	.780
Radialis a. graft	79 (47.3%)	23 (31.1%)	.019
Vein graft	138 (82.6%)	65 (87.8%)	.307
No. of proximal aortic anastomoses	1.8 ± 0.6	1.3 ± 0.8	<.0001
No. of distal anastomoses	3.6 ± 0.9	3.5 ± 0.7	.398
Aortic connector devices	2 (1.2%)	4 (5.4%)	.074
Heartstring anastomosis devices	1 (0.6%)	16 (21.6%)	<.0001
Aorta left untouched	2 (1.2%)	12 (16.2%)	<.0001
NNECVDSG stroke risk score	4.5 ± 2.1	6.0 ± 1.7	<.0001
McSPI stroke risk score	71.5 ± 18.6	86.3 ± 0.6	<.0001

*Continuous variables are reported as the mean ± standard deviation. Risk factors are reported according to the EuroSCORE criteria. TIA indicates transient ischemic attack; LIMA, left internal mammary artery; RIMA, right internal mammary artery; NNECVDSG, The Northern New England Cardiovascular Disease Study Group; McSPI, The Multicenter Study of Perioperative Ischemia Research Group.

400 seconds and it was neutralized at the end of the procedure by protamin sulphate (3.0 mg/kg). Intracoronary shunts were routinely used. Neither heparin nor warfarin was administered postoperatively in these patients unless they had atrial fibrillation. Acetylsalicylic acid, but not clopidogrel, was given to all patients postoperatively.

Statistical Analysis

Statistical analysis was performed using SPSS statistical software (SPSS v. 12.0.1; SPSS, Chicago, IL, USA). Continuous variables are reported as the mean ± standard deviation. The chi-square test and the Fisher exact test were used for univariate analysis of categorical data. The Mann-Whitney U test was used to assess the distribution of continuous variables in different subgroups. The receiver operating characteristics (ROC) analysis was used to assess the validity of the NNECVDSG and McSPI stroke risk scores in predicting the presence of a diseased ascending aorta. Only variables with $P < .2$ were entered into the logistic regression model. A $P < .05$ was considered statistically significant.

RESULTS

A diseased ascending aorta was detected by epiaortic ultrasound in 74 patients (30.7%). During the in-hospital stay, 2 patients (0.8%) died, 3 (1.2%, 1 in the diseased-aorta group) had stroke, 2 (0.8%, 1 in the diseased-aorta group) had transient ischemic attacks, 32 (13.3%) had neuropsychological complications requiring sedation, 15 (6.2%) had pneumonia, 2 (0.8%) had renal failure requiring dialysis, 18 (7.5%) had low cardiac output requiring inotropes >12 hours, and an intra-aortic balloon pump was inserted in 2 patients (0.8%).
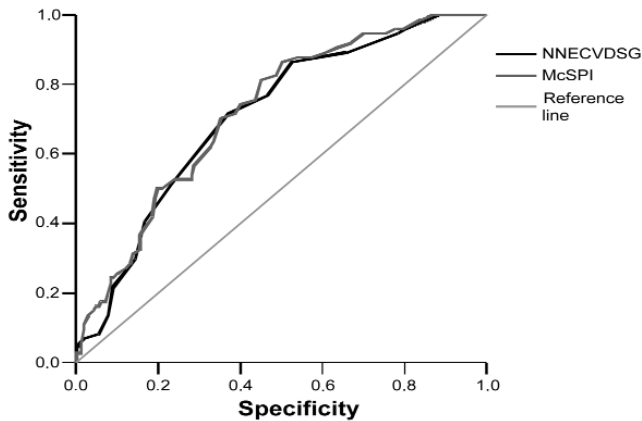
Figure 1. Receiver operating characteristics curves of The Northern New England Cardiovascular Disease Study Group (NNECVDSG) and The Multicenter Study of Perioperative Ischemia Research Group (McSPI) stroke risk scores for prediction of the presence of a diseased ascending aorta at epiaortic ultrasound examination.

Patient's age (P = .002; odds ratio [OR], 1.067, 95% confidence interval [CI], 1.025-1.110), diabetes (P = .023; OR, 2.211; 95% CI, 1.117-4.378), extracardiac arteriopathy (P = .014; OR, 2.567; 95% CI, 1.214-5.428) and urgent/emergency operation (P < .0001; OR, 3.066; 95% CI, 1.685-5.580), were independent preoperative predictors of a diseased ascending aorta.

The area under the ROC curve of the NNECVDSG score in predicting a diseased ascending aorta was 0.710 (95% CI, 0.642-0.778), and that of the McSPI score was 0.722 (95% CI. 0.655-0.788) (Figure 1). The prevalence of a diseased ascending aorta according to these scores' tertiles is depicted in Figure 2. The NNECVDSG score (P = .080; area under the curve, 0.794; 95% CI, 0.611-0.977), but not the McSPI score (P = .137; area under the curve, 0.750; 95% CI, 0.591-0.909), tended to be a significant predictor of postoperative stroke. Patients who suffered from postoperative stroke had NNECVDSG scores of 5.5, 6.5, and 9.5, whereas their McSPI scores were 96, 94, and 78, respectively.

DISCUSSION

We have previously demonstrated that both NNECVDSG and McSPI stroke risk scores are strong predictors of immediate postoperative stroke as well as of 12-year survival freedom from fatal stroke after conventional coronary artery bypass surgery [Kangasniemi 2006]. Since the presence of atherosclerotic lesions of the ascending aorta is the main determinant of postoperative stroke, the present study aimed to evaluate whether these scoring methods are predictors of a diseased ascending aorta. Herein we have observed that most of the variables included in the NNECVDSG and McSPI scoring methods were independent predictors of this condition and that its prevalence significantly increased along with the scores.

Age, extracardiac arteriopathy, and diabetes are well-known risk factors associated with postoperative stroke as well

as with extensive atherosclerosis. Furthermore, patients who underwent urgent/emergent operation had a significantly increased risk of a diseased ascending aorta (43.8% versus 20.6%, P < .0001) and tended to have a significantly increased risk of postoperative stroke (2.9% versus 0%, P = .081). Indeed, unstable angina [Newman 1996] and urgent and emergent operations [Charlesworth 2003] are included as increased stroke risk variables in the McSPI and NNECVDSG scoring methods, respectively.

These findings do not suggest that these stroke risk scoring methods could replace the well-established role of intraoperative epiaortic ultrasound, but rather that their predictive value is mainly due to their ability to identify patients with a diseased ascending aorta. This, in turn, further confirms that the latter condition is a formidable risk factor of postoperative stroke. Thus, NNECVDSG and McSPI scores may be useful to identify those patients who may mostly benefit from OPCAB, most likely by avoiding aortic manipulation when indicated. Their ability to stratify the stroke risk would eventually settle the unsolved controversy about the possible neuroprotective efficacy of OPCAB over conventional coronary artery bypass surgery [Cheng 2005; Wijeysundera 2005].

The small size and the retrospective nature of this study are major limitations and prevent any further important analysis such as any possible correlation between these stroke risk scoring methods and the extent and location of atherosclerotic lesions inside the ascending aorta. The fact that NNECVDSG
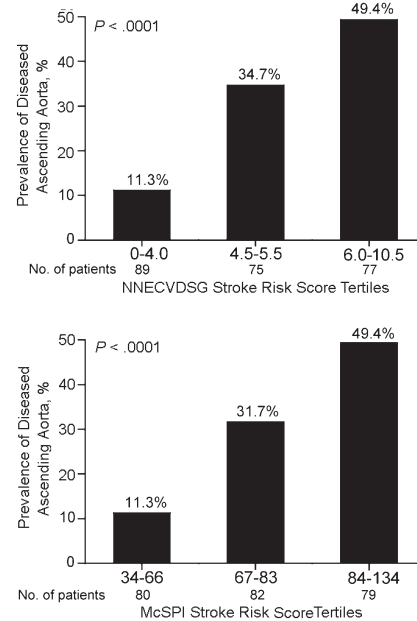

Figure 2. Prevalence of a diseased ascending aorta in patients undergoing off-pump coronary artery bypass surgery according to different tertiles of The Northern New England Cardiovascular Disease Study Group (NNECVDSG) and The Multicenter Study of Perioperative Ischemia Research Group (McSPI) stroke risk scores.

and McSPI stroke risk scores were not significantly associated with postoperative stroke, despite a rather large area under the ROC curve, is likely due to the possible favorable impact of epiaortic ultrasound, which led the surgeon to use proximal anastomotic devices or to avoid aortic manipulation in patients with the most diseased aortas.

These findings confirm the reported high incidence of diseased ascending aortas in patients undergoing coronary artery bypass surgery. Current stroke risk scores are valuable predictors of the increased prevalence of this condition. In particular, the NNECVDSG stroke risk scoring method is of clinical value, its simplicity makes feasible its use at bedside.

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