Clinical utility of $CHADS_2$ and CHA_2DS_2-VASc scoring systems for predicting postoperative atrial fibrillation after cardiac surgery

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Objectives: The presence of postoperative atrial fibrillation predicts a higher short- and long-term mortality rates; however, no scoring system has been used to discriminate patients at high risk for this complication. The aim of this study was to investigate whether the $CHADS_2$ and CHA_2DS_2-VASc scores are useful risk assessment tools for new-onset atrial fibrillation after cardiac surgery.

Methods: A total of 277 consecutive patients who underwent cardiac surgery were prospectively included in this risk stratification study. We calculated the $CHADS_2$ and CHA_2DS_2-VASc scores from the data collected. The primary end point was the development of postoperative atrial fibrillation within 30 days after cardiac surgery.

Results: Eighty-four (30%) of the patients had postoperative atrial fibrillation at a median of 2 days (range, 0-27 days) after cardiac surgery. The $CHADS_2$ and CHA_2DS_2-VASc scores were significant predictors of postoperative atrial fibrillation in separate multivariate regression analyses. The Kaplan-Meier analysis obtained a higher postoperative atrial fibrillation rate when based on the $CHADS_2$ and CHA_2DS_2-VASc scores of at least 2 than when based on scores less than 2 (both log rank, $P < .001$). In addition, the CHA_2DS_2-VASc scores could be used to further stratify the patients with $CHADS_2$ scores of 0 or 1 into 2 groups with different postoperative atrial fibrillation rates at a cutoff value of 2 (12% vs 32%; $P = .01$).

Conclusions: $CHADS_2$ and CHA_2DS_2-VASc scores were predictive of postoperative atrial fibrillation after cardiac surgery and may be helpful for identifying high-risk patients. (J Thorac Cardiovasc Surg 2013;146:919-26)

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Atrial fibrillation (AF) occurs in 205 to 40% of patients undergoing cardiac surgery, with the arrhythmia usually occurring between the second and fourth day after cardiac surgery.[1-3] Studies have demonstrated that various clinical risk factors, including advanced age, hypertension, left ventricular (LV) hypertrophy, LV systolic and diastolic dysfunction, and left atrial function and dimension, are closely linked to postoperative AF (POAF).[4-6] Although POAF is usually self-limiting, patients with POAF do tend to have longer hospital stays, increased perioperative morbidity, and greater early and long-term mortalites.[4-7]

It is advisable that prophylactic therapy with antiarrhythmic drugs be administered to decrease the incidence of POAF[8,9]; however, the use of prophylactic treatment in all patients to prevent POAF is not cost-effective.[2] In addition, such treatments may have adverse effects. Because the use of prophylactic therapy for all patients who undergo cardiac surgery is not reasonable, the identification of patients at risk for POAF would be helpful.

Use of the CHA_2DS_2-VASc score (congestive heart failure; hypertension; age $\geq$75 years [doubled]; type 2 diabetes; previous stroke, transient ischemic attack [TIA], or thromboembolism [doubled]; vascular disease; age 65-75 years; and sex category), which extends the $CHADS_2$ score (congestive heart failure, hypertension, age $\geq$75 years, type 2 diabetes, and previous stroke or TIA [doubled]) by considering additional stroke risk factors, was recently recommended to guide antithrombotic therapy in patients with AF or atrial flutter.[10-12] Each component of the $CHADS_2$ and CHA_2DS_2-VASc scores has been associated with the ventricular remodeling, LV diastolic function, and left atrial enlargement that may lead to atrial arrhythmia[13-15]; however, no published studies have investigated the association between the $CHADS_2$ and CHA_2DS_2-VASc scores in the prediction of POAF. This study aimed to assess the $CHADS_2$ and CHA_2DS_2-VASc scores for predicting the initiation of new-onset POAF after cardiac surgery.

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Abbreviations and Acronyms

AF = atrial fibrillation
CABG = coronary artery bypass grafting
CI = confidence interval
E = early mitral inflow velocity
e′ = medial mitral annular velocity during passive filling
LV = left ventricular
LVEDD = left ventricular end-diastolic diameter
LVM = left ventricular mass
OR = odds ratio
PAD = peripheral arterial disease
POAF = postoperative atrial fibrillation
PWTD = posterior wall thickness
SWTD = interventricular septal wall thickness
TIA = transient ischemic attack

MATERIALS AND METHODS

Patient Population

This prospective study recruited 340 consecutive patients who underwent cardiac surgery in our institution between January 2008 and December 2011. All had preoperative sinus rhythm and underwent isolated coronary artery bypass grafting (CABG), valvular repair or replacement, or both combined and survived the operation. We excluded patients with a preoperative history of AF, a pacemaker, Cox maze or radiofrequency ablation procedure for atrial arrhythmia, moderate or severe mitral stenosis or regurgitation, history of myocardial infarction in recent 3 months, or incomplete diastolic function assessment. A total of 280 patients met the inclusion criteria and were included in the study. After cardiac surgery, 3 patients who received early antiarrhythmic drugs for ventricular arrhythmia were excluded from the study. Finally, a total of 277 patients were enrolled in the study (mean age, 62.1 ± 9.7 years; 213 male).

Clinical reports, echocardiographic reports, carotid ultrasonography, and complete medical records were prospectively collected to investigate the relationship among $CHADS_2$, CHA_2DS_2-VASc score, and the risk of new-onset POAF after cardiac surgery. This study was approved by the institutional review board for human subjects at our institution, and the patients provided written, informed consent before participating in the study.

$CHADS_2$ and CHA_2DS_2-VASc Scores

The $CHADS_2$ score was calculated for all the patients by assigning 1 point for each of the following criteria: *c*ongestive heart failure, hypertension, age at least 75 years, and diabetes mellitus. A further 2 points was added for the criterion of previous *s*troke or TIA. In contrast, the CHA_2DS_2-VASc score is based on a point system in which 2 points each are assigned for age at least 75 years and for history of *s*troke, TIA, or thromboembolism and 1 point is assigned for each of the following criteria: congestive heart failure, hypertension, diabetes mellitus, age 65 to 75 years, vascular disease (defined as previous myocardial infarction, complex aortic plaque, carotid disease, and peripheral arterial disease [PAD], including intermittent claudication, previous surgery or percutaneous intervention on the abdominal aorta or the lower extremity vessels, and arterial and venous thrombosis), and female sex category.[10,11] The cutoff values of the $CHADS_2$ and CHA_2DS_2-VASc scores used for grouping were determined according to risk of stroke and atrial properties determined in earlier studies.[11,16,17]

POAF Definition

The study defined POAF in the same manner as earlier studies that defined POAF on the basis of documented AF episodes lasting longer than 30 seconds recorded by continuous telemetry throughout hospitalization or by electrocardiography within the 30-day follow-up period after cardiac surgery.[5,18] A standard 12-lead electrocardiogram was recorded for every patient who had a suspected arrhythmic event.

Echocardiography

Echocardiography was performed by an experienced sonographer (S.K.C.) before the index cardiac procedure. Doppler echocardiography was performed to determine the early mitral inflow velocity (E), and a tissue Doppler imaging evaluation was performed to determine the medial mitral annular velocity during passive filling (e′).[19,20] Diastolic dysfunction was defined as an E/e′ ratio greater than 15, as previously described elsewhere.[20] LV size and wall thickness were determined with M-mode measurement. The diastolic measurements of LV end-diastolic diameter (LVEDD), interventricular septal wall thickness (SWTD), and posterior wall thickness (PWTD, all in millimeters) were used to calculate LV mass (LVM) in grams according to the formula recommended by the American Society of Echocardiography[21]:

$$\mathrm{LVM} = 0.8\left\{1.04\left[(\mathrm{LVEDD} + \mathrm{SWTD} + \mathrm{PWTD})^3 - (\mathrm{LVEDD})^3\right]\right\} + 0.6$$

The LVM index (in grams per square meter) was defined as LVM normalized by body surface area.[21]

Carotid Ultrasonography

The diagnosis of carotid artery stenosis was based on the ultrasonographic analysis, and all carotid ultrasonographic studies were performed before cardiac surgery. The method of carotid artery stenosis measurement has been reported previously.[22] In brief, the equipment used was a SONOS 5500 ultrasound system (Philips Healthcare, Andover, Mass) equipped with a 3- to 11-MHz real-time B-mode scanner and a 3.6-MHz pulsed Doppler mode scanner. Carotid artery segments, including the common carotid artery, internal carotid artery, and external carotid artery, were measured bilaterally by an experienced neurologist (L.M.L.) who was blinded to each subject's information. The presence of plaques was defined as localized echo structures encroaching into the arterial lumen of at least 50% of the surrounding intimal media thickness value. The presence of significant carotid artery stenosis was defined as a large plaque comprising at least 50% of the diameter of the carotid artery stenosis.

Statistics

In this study, we enrolled around 100 patients with risk scale scores of at least 2 and 170 subjects with scores lower than 2. Our preliminary data indicated that the POAF rate among those with low score would be 20%. If the true relative risk of subjects with high scores relative to those with low scores were 2, we would be able to reject the null hypothesis that the relative risk was equal to 1 with probability (power) of 0.8. The type I error probability associated with this test of this null hypothesis is 0.05.

Quantitative data are expressed as mean ± SD and were compared with 2-sample *t* tests for independent samples. Differences in proportion were compared with a χ^2 test or Fisher exact test as appropriate. Univariate association of variables with the outcome of POAF within 30 days was assessed with multivariate logistic regression. For each variable, the odds ratio (OR), 95% confidence interval (CI), and *P* value are provided. Exploratory data analyses were conducted with univariate summaries to examine distributions of key variables. Variables significantly associated with POAF after univariate analysis ($P < .05$) and those that were established risk factors were entered in a multivariable logistic regression model to identify the independent predictors of POAF. The POAF-free survival curves were constructed according to the Kaplan–Meier method. The

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