Postoperative Atrial Fibrillation After Thoracic Aortic Surgery

Miwa Arakawa, MD, Hiroaki Miyata, PhD, Naomichi Uchida, MD, PhD, Noboru Motomura, MD, PhD, Akira Katayama, MD, Kentaro Tamura, MD, Taijiro Sueda, MD, PhD, and Shinichi Takamoto, MD, PhD

Department of Cardiovascular Surgery, Hiroshima City Asa Hospital, Hiroshima; Department of Healthcare Quality Assessment Graduate School of Medicine, University of Tokyo, Tokyo; Department of Cardiovascular Surgery, Tsuchiya General Hospital, Hirosima; Department of Cardiovascular Surgery, The Sakakibara Heart Institute of Okayama, Okayama; Department of Surgery, Graduate School of Biomedical Sciences, Hiroshima University, Hiroshima; and Department of Cardiovascular Surgery, Mitsui Memorial Hospital, Tokyo, Japan

Background. **Postoperative atrial fibrillation (POAF) increases considerably the chances of morbidity and mortality after cardiac surgery. The objective of this study was to identify the major risk factors responsible for POAF after thoracic aortic surgery in order to define preventive measures.**

Methods. **We analyzed 12,260 records (between January 1, 2004, and December 31, 2008) obtained from the Japan Adult Cardiovascular Surgery Database. Patients with history of AF were excluded. Data were collected for 12 preoperative and 10 operative risk factors that had been proven or believed to influence POAF. The relationship between the risk factors and outcome was assessed by the Fisher exact test, Student *t* test, and multiple logistic regression analysis.**

Results. **The patients' mean age (± standard deviation) was 67.5 ± 12.7 years, and 27% of the subjects were women. The incidence of POAF was 17.1%. The following risk factors were associated with increased POAF: age ($p < 0.0001$), history of smoking ($p <= 0.020$), hypertension ($p = 0.020$), congestive heart failure ($p < 0.0001$), urgent operation ($p = 0.023$), and concomitant with nonelective coronary artery bypass ($p = 0.022$). Postoperative mortality and postoperative stroke were significantly increased in patients with POAF ($p < 0.0001$ in both cases). The odds ratios for the POAF risk factors were as follows: replacement of the ascending aorta, 1.67; aortic arch, 1.62; aortic root, 1.42; concomitant with valve operation, 1.35; age, 1.27; and urgent operation, 1.22.**

Conclusions. **Several risk factors contribute to the incidence of POAF after thoracic aortic surgery. We found that POAF significantly increased 30-day operative mortality ($p < 0.0001$). Our findings can be used to develop a risk stratification system for the prediction of POAF.**

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Atrial fibrillation (AF) is a common type of arrhythmia that is frequently encountered after cardiac surgery and is considered a transient phenomenon [1]. Recently, many studies have reported that postoperative atrial fibrillation (POAF) is associated with longer hospital stay and predicts greater postoperative mortality [2]. The incidence of POAF has increased continuously over the past decades, and this is believed to be due to the aging of the population undergoing heart surgery. However, the incidence of POAF reported in previous studies varies between 20% and 50%, depending on the variety of operation, definitions of POAF itself, and methods of detection [3]. The pathophysiology of POAF after heart surgery is not precisely known; however, various risk factors have been reported and many studies have evaluated the prophylactic effect of different pharmacologic or physical interventions [4]. Thoracic aortic surgery is one of the most challenging operations in cardiac surgery and several possible confounding aspects exist; therefore, POAF management is directly associated with improved operative outcome. This study is the first in the Japanese population to stratify the risks for the development of POAF after thoracic aortic surgery and our findings can be useful for improving the outcome of thoracic aortic surgery.

Material and Methods

The Japan Adult Cardiovascular Surgery Database (JACVSD) was created in 2000 with the aim of recording and estimating surgical outcomes after cardiovascular procedures in various centers across Japan. This study was approved by our Institutional Review Board, and informed consent to participate in this study was obtained from each patient. We obtained data from this database to analyze the factors contributing to the occurrence of POAF after thoracic aortic surgery. The cardiovascular division of JACVSD for adults currently captures clinical information from 244 hospitals (45% of all Japanese units performing cardiac surgery in 2008).

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Address correspondence to Dr Arakawa, 2-1-1 Kabeminami, Asakita-ku, Hiroshima 731-0293, Japan; e-mail: sutohmiwa@gmail.com.

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Abbreviations and Acronyms

AF	=	atrial fibrillation
AFL	=	atrial flutter
BMI	=	body mass index
BSA	=	body surface area
CABG	=	coronary artery bypass grafting
CHF	=	congestive heart failure
JACVSD	=	The Japan Adult Cardiovascular Surgery Database
POAF	=	postoperative atrial fibrillation
ROC	=	receiver-operating characteristic
STS	=	The Society of Thoracic Surgeons

The data collection form contains 255 variables (definitions are available online at http://www.jacvsd.umin.jp), which are almost identical to those in the Society of Thoracic Surgeons (STS) National Database (definitions are available online at http://sts.org). The JACVSD has developed software for web-based data collection; the data manager of each participating hospital submits data electronically to the central office through this web-based data collection system. Although participation in the JACVSD is voluntary, completeness of data is a high priority. Accuracy of the submitted data is maintained through audits; these audits are carried out by administrative office members who pay monthly visits to the participating hospitals to validate the data against clinical records. Data were further validated by independently comparing the volume of cardiac surgery conducted at the hospitals participating in the JACVSD with that reported in the Japanese Association for Thoracic Surgery annual survey. We examined the data of all cardiovascular surgeries (aortic surgery patients with atrial fibrillation) performed between January 1, 2004, and December 31, 2008. First, those JACVSD records that had been obtained without patients' informed consent were excluded from this analysis. Records with missing age (or age that was out of range), sex, or 30-day status (see "Endpoints") were also excluded. After exclusion of incomplete data from the analysis, the population for this risk model analysis consisted of 12,260 cardiovascular patient data from 244 participating sites throughout Japan.

We identified new- onset of AF after thoracic aortic surgery (postoperative AF, POAF) as the primary study variable. Therefore, any patient with a history of preoperative AF was excluded from the POAF group. The JACVSD database contains records of the preoperative history of AF, which was obtained by chart reviews and patient interviews. The study defines POAF as the occurrence of POAF or atrial flutter requiring treatment (by administration of agents such as beta-blockers, calcium-channel blockers, amiodarone, anticoagulation, or by cardioversion) as STS database definition. If the patient did not have a history of AF or paroxysmal AF or atrial flutter and was in sinus rhythm preoperatively, and developed AF after the operation, such patients were classified in the POAF group.

Endpoints

The primary outcome measure of JACVSD was 30-day mortality, defined as death within 30 days of an operation regardless of the patient's geographic location. It also included death within 30 days of an operation even if the patient has been discharged from the hospital. The secondary outcome of the JACVSD was 30-day operative mortality, which includes any patient who died during the index hospitalization regardless of the length of hospital stay, and any patient who died after being discharged from the hospital, within 30 days of the operation, as defined in the STS National Database. Using the definition from a previous study [5], major morbidity was defined as any of the following 5 postoperative in-hospital complications: stroke, reoperation for any reason, need for mechanical ventilation for more than 24 hours after the surgery, renal failure, or deep sternal wound infection [6].

The primary outcome measure of this study was the presence of new onset of AF after operation. To better ascertain the risk factors of POAF we identified 34 covariates of long-term mortality risk, and harvested this information from the JACVSD database for use in a risk-adjustment analysis using standard JACVSD definitions or each risk factor and outcome. The analyzed covariates included age, sex, race, left ventricular ejection fraction, history of myocardial infarction, congestive heart failure, New York Heart Association functional class, stroke, hypertension, diabetes mellitus, renal failure, dyslipidemia, smoking, chronic obstructive lung disease, peripheral vascular disease, recent creatinine level, dialysis status, elective or urgent surgery, and the presence of any valvular disorder or postoperative complications (such as myocardial infarction, stroke, and postoperative respiratory distress syndrome).

Statistical Analysis

We used bivariate tests to compare the differences between 2 groups; patients with new-onset AF and patients whose sinus rhythm was maintained after surgery. Fisher exact tests and χ^2 tests were used for categoric covariates; namely, age, sex, body surface area, body mass index, and creatinine. Unpaired t tests and Wilcoxon rank sum tests were used for continuous covariates; namely, diabetes mellitus, renal failure, hypertension, chronic lung disease, dyslipidemia, cerebral vascular disease, smoking history, peripheral vascular disease, neurologic dysfunction, chronic obstructive pulmonary disease, dialysis, myocardial infarction, congestive heart disease, urgent operation, body mass index greater than 30, nonelective coronary artery bypass, aortic stenosis, aortic insufficiency, mitral insufficiency, and reoperation.

To develop risk models of atrial fibrillation we conducted multivariate stepwise logistic regression analysis for each outcome. The stability of the model was checked every time a variable was eliminated. When all the statistically nonsignificant variables ($p < 0.1$) had been eliminated from the model, we evaluated the "goodness-of-fit" and used the area under the receiver operating