Left Atrial Appendage Velocity as a Predictor of Atrial Fibrillation After Cardiac Surgery

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Objective: **To determine if there is an association between left atrial appendage velocity and the development of postoperative atrial fibrillation (POAF).**

Design: **Single institution retrospective study performed between January 2013 and December 2013.**

Setting: **Single-institution, university hospital.**

Participants: **Five hundred sixty-two adult patients undergoing cardiac surgery utilizing cardiopulmonary bypass.**

Interventions: **No interventions for the purpose of this study.**

Measurements and Main Results: **Left atrial appendage velocity, measured by transesophageal echocardiogram, ranged from 8 cm/sec to 126 cm/sec. The development of POAF within the first 3 days after cardiac surgery was 38.3%. The authors found that patients with a lower left atrial appendage velocity had a higher risk of developing POAF. In the adjusted logistic regression model, there was an 11% decrease in the odds of POAF for each 10-unit (cm/sec) increase in the left atrial appendage velocity ($p = 0.044$).**

Conclusions: **Decreasing left atrial appendage velocity is an independent predictor of risk for the development of POAF following cardiac surgery with cardiopulmonary bypass.**

KEY WORDS: postoperative atrial fibrillation, transesophageal echocardiography, left atrial appendage velocity, cardiac surgery

ATRIAL FIBRILLATION (AF) after cardiac surgery is a common postoperative complication. While the incidence of postoperative AF after major noncardiac surgery is less than 5%,[1] it occurs in approximately 15% to 40% of coronary artery bypass graft (CABG) patients[2-5] and more than 60% of patients undergoing combined CABG and valve surgery.[2,6]

While several risk models have been developed and validated for predicting the development of postoperative AF in cardiac surgical patients,[3,7,8] these models were designed only for patients undergoing CABG surgery, highlighting the need for predictive variables that can be generalizable to all cardiac surgical patients. The authors hypothesized that measurement of left atrial appendage velocity is one such predictive variable. Patients at high risk for developing postoperative AF likely have atria that contract less vigorously. Reduced atrial contraction would translate to lower left atrial appendage velocity. Hence, the authors hypothesized that there would be a correlation between left atrial appendage velocity and risk of developing postoperative AF. If such an association exists, prophylactic antiarrhythmic interventions could be targeted to that subset of patients at highest risk for developing postoperative AF.

METHODS

After obtaining institutional review board approval, the authors conducted a retrospective analysis of the electronic records of all adult cardiac surgery performed over the period from January 1, 2013 to December 31, 2013. This included patients undergoing CABG, single-valve surgery, multiple-valve surgery, combined CABG and valve surgery, and aortic surgery. Patients were excluded if they were younger than 18 years of age, had cardiac surgery without the use of cardiopulmonary bypass (CPB) eg off-pump CABG or transcatheter aortic valve replacement), if they died intraoperatively, if they were in AF at the time of surgery, or if transesophageal echocardiography (TEE) was not used. Among patients who had multiple cardiac procedures requiring CPB during the same admission, only the left atrial appendage velocity from the initial procedure was included in the analysis.

General anesthesia was induced after appropriate monitors were placed, patients were endotracheally intubated, and a TEE probe was passed. Anesthetic medications included midazolam, fentanyl, etomidate, and rocuronium for the induction of general anesthesia. Sevoflurane, fentanyl, and rocuronium were used for the maintenance of anesthesia. Patients with contraindications to using a TEE, such as active gastrointestinal bleeding or inability to pass TEE probe, were excluded from the analysis. A comprehensive TEE examination was performed prior to surgical incision, which included examination of the left atrial appendage. Views of the left atrial appendage included the midesophageal 4-chamber view at 0 degrees then multiplane to 30, 60, and 90 degrees in order to find the optimal image to measure the velocity. Color-flow and pulsed-wave Doppler measurements of the appendage were performed. The velocity of the blood flow being expelled from the appendage was measured, as that would be more indicative of the contractile nature of the appendage (Fig 1). Velocities measured in each of the views were similar. However, the optimal image varied depending on the patient's anatomy. General anesthesia had minimal effect on the appendage velocities, as TEE examinations performed previously under sedation have generated similar velocities.[9]

Postoperative rhythm was monitored and documented in the chart by a nurse or physician. This was done either by

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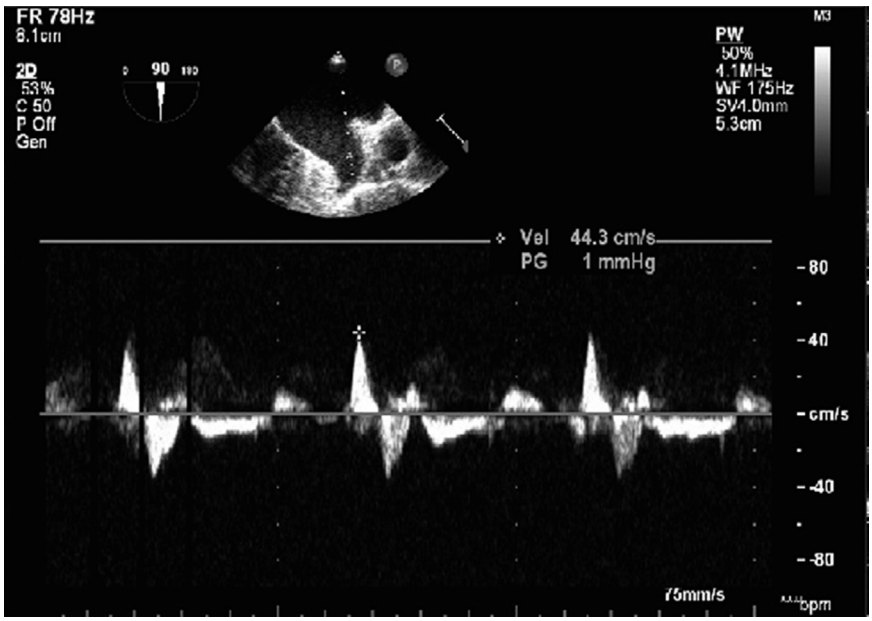

Fig 1. Transesophageal echocardiogram depicting pulsed-wave Doppler signal of the left atrial appendage. Peak left atrial appendage ejection velocity (44.3 cm/sec) in this representative patient is demonstrated in the lower half of the figure.

continuous telemetry monitoring or with electrocardiogram. Patients were considered to have developed postoperative AF if AF was documented within the first three days after cardiac surgery.

STATISTICAL ANALYSIS

The authors tested normality using the Shapiro-Wilk test and Q-Q plots. They used the Student's t-test or Wilcoxon rank sum test for between-group comparisons as appropriate. Chi-square test and Fisher's exact test were used for inferences on proportions.

The analysis of the primary outcome, presence of post-operative AF after cardiac surgery, was performed using logistic regression. The model building was done according to Hosmer and Lemeshow.[10] Variables identified as potential confounding factors in previous studies and those with a p value < 0.25 in the univariable analysis were included in the multivariable logistic regression model. Using a backward elimination approach, the likelihood ratio test comparing the model, including the variable, with the nested model excluding it, was used to assess whether the variable contributed significantly to the model ($p < 0.20$). The Hosmer-Lemeshow goodness-of-fit test was used to assess calibration of the model. The model discrimination was evaluated through the receiver operating characteristic (ROC) area under the curve, and the Youden index was used for the selection of the optimal threshold value (cutoff point) for the left atrial appendage velocity.[11]

Data are expressed as mean (standard deviation [SD]), median (interquartile range [IQR]) or odds ratio (95% confidence interval), unless otherwise stated. A 2-sided p value less than 0.05 was considered significant. All analyses were performed with STATA/SE version 12 (StataCorp LP, College Station, TX).

RESULTS

A total of 924 cardiac surgery patients were identified. Of those, 362 were excluded from the analysis. (One hundred forty-six were patients under age 18, 136 had incomplete data for the analysis of the primary outcome, 64 procedures were performed without CPB, and 16 were reoperations.)

Of the final 562 patients analyzed, 215 developed post-operative AF (38.3%). The baseline characteristics of the patients are listed in Table 1. The results of the univariable analysis using logistic regression for postoperative AF are shown in Table 2. The results of the multivariable logistic regression analysis are shown in Table 3.

For the multivariable model, the authors began with a model containing the variables left atrial appendage velocity, history of AF, time on CPB, gender, age and type of surgery (CABG versus no CABG). In the final adjusted logistic regression

Table 1. Baseline Characteristics.

	POAF Absent	POAF Present	
	n = 347	n = 215	p Value
Male/female (n of patients)	229/118	138/77	0.60
Age, years*	63.8 (13.4)	72.0 (10)	<0.001
History of AF, yes†	38 (11%)	91 (42%)	<0.001
Type of surgery†			0.88
CABG	94 (27%)	57 (27%)	
No CABG	253 (73%)	158 (73%)	
CPB time, minutes‡	97 (78-117)	100 (79-140)	0.02
LAAV, cm/sec‡	42.3 (34.2-51)	35.9 (23.7-48.6)	<0.001

Abbreviations: AF, atrial fibrillation; CABG, coronary artery bypass graft; CPB, cardiopulmonary bypass; LAAV, left atrial appendage velocity; POAF, postoperative atrial fibrillation.

* Values are mean (SD).

† Number of patients (%).

‡ Values are median (IQR).