

Association between Doppler Flow of Atrial Fibrillatory Contraction and Recurrence of Atrial Fibrillation after Electrical Cardioversion

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Background: Left atrial fibrillatory contraction (Afc) flow can be frequently observed interspersed between two successive mitral E waves in patients with atrial fibrillation (AF). The aim of this study was to test the hypothesis that Afc is related to the maintenance of sinus rhythm after electrical cardioversion for AF.

Methods: In this retrospective study, the records of a total of 137 patients with AF who underwent successful electrical cardioversion were examined. Conventional echocardiographic measurements, including left atrial volume index (LAVI), were obtained, and the appearance of Afc flow was also evaluated before cardioversion. Patients were followed to a clinical end point defined as recurrent AF during the study period.

Results: AF recurrence was noted in 100 patients (73%) over a mean follow-up period of 5 months. The patients with recurrent AF had greater LAVI and left atrial dimensions and had a lower frequency of Afc flow (57.0% vs 86.5%, $P < .001$): both the velocity and velocity-time integral (VTI) of Afc flow significantly decreased. Receiver operating characteristic curve analysis showed that the Afc flow VTI and velocity had stronger associations with AF recurrence than did LAVI (areas under the curve: VTI, 0.96; velocity, 0.86; LAVI, 0.71). A VTI of 3.1 cm and velocity of 32 cm/sec for Afc flow were the best cutoff values for AF recurrence. Afc flow VTI (hazard ratio, 0.70; 95% confidence interval, 0.51–0.96) and velocity (hazard ratio, 0.97; 95% confidence interval, 0.94–0.99) were significantly related to AF recurrence in a multivariate Cox regression analysis.

Conclusions: Return of AF after successful electrical cardioversion may be associated with Afc Doppler flow velocity and VTI measured immediately before cardioversion. (*J Am Soc Echocardiogr* 2014;27:1107-12.)

Keywords: Atrial fibrillation, Atrial fibrillatory contraction, Echocardiography, Cardioversion

Atrial fibrillation (AF) has been considered a strong risk factor for heart failure and even ischemic stroke.¹⁻³ The prevalence of AF has a close relationship with left atrial (LA) enlargement and dysfunction.^{4,5} In the spectrum of AF treatment, the cardioversion of AF into normal sinus rhythm is believed to have a key role. Unfortunately, the recurrence of AF in the short or long term is relatively high, estimated to be up to 70% a year.^{6,7}

In the effort to find predictors of AF recurrence, LA size has been the most useful parameter for clinical physicians.^{8,9} However, LA dimensions poorly represent true LA size because of the discrepancy between LA dimensions (anteroposterior or mediolateral) and

volume, and no clear cutoff value has been established for LA volume or LA volume index (LAVI) that predicts AF recurrence, despite the most favorable methods.^{5,10} LA functional studies, including assessment of LA strain or strain rate, are of limited use because they require sophisticated software.¹¹⁻¹⁴

Atrial fibrillatory contraction (Afc) flow (Figure 1) can be noted immediately after early diastolic mitral inflow. Considering low flow velocity, Afc should be related to LA mechanical activity, and we speculate that the presence of Afc flow could be associated with AF recurrence. However, there has been no study or data regarding Afc flow. The meaning or implications of Afc flow have not been reported. Therefore, we tried to evaluate Afc flow in patients scheduled to undergo electrical direct-current (DC) cardioversion and to assess the prognostic ability of Afc flow compared with conventional echocardiographic parameters.

METHODS

Study Population

This retrospective observational study included patients with AF treated at a tertiary hospital between March 1, 2011, and October 20, 2013. We performed a retrospective analysis of a database to examine the relationship between Afc flow and recurrence of AF after

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Abbreviations

AF = Atrial fibrillation
Afc = Atrial fibrillatory contraction
AUC = Area under the curve
DC = Direct-current
LA = Left atrial
LAVI = Left atrial volume index
LV = Left ventricular
ROC = Receiver operating characteristic
VTI = Velocity-time integral

DC cardioversion. Patients with persistent AF scheduled for electrical DC cardioversion were enrolled. The inclusion criteria were the presence of documented persistent AF, age > 18 years, and oral anticoagulation treatment for 4 weeks or exclusion of intracardiac thrombus using transesophageal echocardiography before cardioversion. In addition, the exclusion criteria were valvular AF, atrial flutter, left ventricular (LV) dysfunction (ejection fraction < 45%), or history of implanted prosthetic valves or pacing devices. A total of 171 patients

Additionally, 24-hour Holter electrocardiography was performed every 6 months.

Statistical Analysis

Data analyses were performed with MedCalc for Windows version 11.0.1.0 (MedCalc Software, Ostend, Belgium). All values are presented as mean \pm SD for continuous variables and as frequencies for discrete variables. Categorical variables were analyzed by using χ^2 tests, and continuous variables were analyzed by using Student's *t* tests. The selected variables were derived from univariate analysis, and then multivariate Cox regression analyses were performed. LA dimensions and LAVI displayed bilateral interference or caused significant multicollinearity in the multivariate analysis. We decided to include the variable LAVI as a predictor in the multivariate analysis because LAVI is more frequently used for evaluating LA size than LA dimensions. Receiver operating characteristic (ROC) curves and the areas under the curves (AUCs) were obtained to compare the predictive value of the parameters. Cumulative AF recurrence-free curves were constructed using the Kaplan-Meier method. *P* values were two sided, and *P* values < .05 were considered to indicate statistical significance.

RESULTS

Baseline and Clinical Characteristics

Of the 137 patients, 37 (27%) undergoing DC cardioversion remained in normal sinus rhythm throughout the follow-up period (mean, 163 days). The baseline and clinical characteristics are presented in [Table 1](#). Between the two groups according to AF recurrence, there were no differences in terms of clinical or medical factors, including AF duration. Of note, the medications used to maintain normal sinus rhythm after DC cardioversion were also similar. Of 100 recurrence events, 95 patients had AF documented on electrocardiography within 6 months before Holter monitoring. The remaining five patients had 6-month Holter follow-up tests. In the no-recurrence group, 30 of 37 patients underwent 6-month Holter monitoring during study period (81%). Indeed, to detect AF recurrence after 6 months of discharge, Holter monitoring was performed in 35 of 42 patients (83%).

Echocardiographic Findings

The echocardiographic parameters for all patients are shown in [Table 2](#). There were no significant differences in LV size, LV ejection fraction, mitral E flow, or tissue Doppler velocities. LA dimensions and LAVI were significantly greater in the AF-recurrence group compared with the no-recurrence group. The appearance of Afc flow occurred in 57.0% of patients with AF recurrence, compared with 86.5% of patients without AF recurrence (*P* < .001). There was a decreased velocity of Afc flow and a smaller VTI for Afc flow in the AF-recurrence group.

Associated Parameters for Atrial Fibrillation

To evaluate the usefulness of various factors associated with AF recurrence, univariate and multivariate analyses were performed ([Table 3](#)). In the univariate analysis, LAVI, Afc flow velocity, and VTI were associated with AF recurrence. In a multivariate Cox regression analysis with these factors, only Afc flow velocity and VTI were still significant independent factors. ROC curves were generated to compare LAVI, Afc flow velocity, and VTI as significant factors of AF

who underwent echocardiography before cardioversion were evaluated. Of those, 34 patients were excluded: 15 were not followed up after sinus conversion and did not visit outpatient clinic, and 19 had poor echocardiographic images with regard to LV dimensions or volume, and mitral inflow Doppler could not be observed clearly in these patients. Ultimately, 137 patients were analyzed in this study. Written informed consent was obtained from each patient before electrical DC cardioversion, and the study was approved by the Keimyung University Hospital Institutional Review Board.

Echocardiography and Cardioversion

Conventional echocardiography was performed, and all echocardiographic data were gathered according to the recommendations of the American Society of Echocardiography.¹⁵ Images of the standard parasternal and apical views were obtained with the patient in the left lateral decubitus position. LV end-systolic and end-diastolic dimensions and interventricular septal and posterior wall thicknesses were measured by using a two-dimensional linear measurement in the parasternal long-axis view. The ejection fraction was calculated by using the biplane Simpson's method. In particular, LA dimensions were measured by using the two-dimensional anteroposterior linear method from the parasternal long-axis view. LA volume was measured with the modified biplane area-length method, and the LAVI was derived from LA volume indexed to body surface area. From the apical four-chamber view, the pulsed-wave Doppler sample volume was placed at the mitral leaflet tips, and the mitral inflow was recorded for ≥ 10 to 15 cycles to detect Afc flow ([Figure 1](#)). In case of visible Afc flow, its peak velocity and velocity-time integral (VTI) were measured. Pulsed-wave tissue Doppler recordings were obtained in the apical four-chamber view; the peak systolic and early diastolic mitral annular velocities were obtained with annular movement aligned with the sample volume line, and the averaged E/e' ratio was derived. All echocardiographic data, including the Doppler of Afc flow and its measures, were analyzed by two independent observers (J.H. Jeon and M.Y. Kim). After a thorough echocardiographic examination, electrical DC cardioversion (200–300 J) was performed until successful cardioversion, and the use of antiarrhythmic agents was left to the discretion of the physicians.

Outcomes Assessment

Immediately after cardioversion, all patients were scheduled for daily follow-up during the admission and for regular follow-up visits after discharge, including 12-lead electrocardiography every 3 months.

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