Relation of Electrocardiographic Left Atrial Abnormalities to Risk of Stroke in Patients with Atrial Fibrillation

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The P-wave terminal force in lead V_1 ($PTFV_1$) on the 12-lead electrocardiogram (ECG) quantifies left atrial (LA) structural and electrophysiologic abnormalities. We aimed to evaluate the association between $PTFV_1$ and cerebrovascular accident (CVA) as well as LA structure and function in patients with atrial fibrillation (AF). We conducted a cross-sectional study of 229 patients with AF (60 ± 10 years, 72% men) with (n = 21) and without (n = 208) a history of CVA, who underwent preablation ECG and cardiac magnetic resonance in sinus rhythm. $PTFV_1$ was defined as the duration (in milliseconds) of the downward deflection of the P wave in lead V_1 multiplied by the absolute value of its amplitude (in microvolts) on ECG. $PTFV_1$ is associated with LA minimum volume (V_{min}) and left ventricular ejection fraction but not associated with the extent of LA fibrosis quantified by cardiac magnetic resonance late gadolinium enhancement. In addition, $PTFV_1$ is associated with CVA independent of the CHA_2DS_2-VASc score and LA V_{min} (odds ratio 1.23; 95% confidence interval 1.08 to 1.40; p = 0.002). Furthermore, $PTFV_1$ has an incremental value over the CHA_2DS_2-VASc score as a marker of CVA (p <0.001). In conclusion, ECG-defined $PTFV_1$ is independent marker of stroke in patients with AF and reflects the underlying LA remodeling. Our findings suggest that evaluation of $PTFV_1$ can improve the current risk stratification of stroke. © 2018 Elsevier Inc. All rights reserved. **(Am J Cardiol 2018;122:242–247)**

Atrial fibrillation (AF) is associated with a fivefold increased risk of thromboembolism.[1] The current approach to estimate the risk of stroke in patients with AF is the CHA_2DS_2-VAS_C scoring system, and oral anticoagulation is recommended for the patients with a score of 2 or greater. Although the CHA_2DS_2-VAS_C scoring system is an extremely simple and cost-effective method to estimate the risk of stroke, there is a clinical need for an improved method that provides an incremental value over the CHA_2DS_2-VASc score by quantifying the underlying left atrial (LA) remodeling associated with AF, and yet is equivalently simple and cost-effective. The P-wave terminal force in lead V_1 ($PTFV_1$) on the standard 12-lead electrocardiogram (ECG) is a simple parameter to quantify structural[2,3] and electrophysiologic abnormalities of the left atrium.[4] In this study, we aimed to evaluate the association between $PTFV_1$ and LA remodeling such as LA size and fibrosis derived from cardiac magnetic resonance (CMR) in patients with AF. We also aimed to evaluate the association between $PTFV_1$ and cerebrovascular accident (CVA).

Methods

We conducted a prospective cross-sectional study of 346 consecutive patients with drug-refractory symptomatic AF referred for CMR imaging for definition of pulmonary vein anatomy before the first-time catheter ablation of AF. Patients with AF at the time of ECG or CMR were excluded (n = 117; Figure 1). The remaining 229 patients who were in sinus rhythm at the time of both ECG and CMR were included in the final analysis. The CVA group (n = 21; 9.2%) was defined as those with a history of ischemic

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See page 246 for disclosure information.

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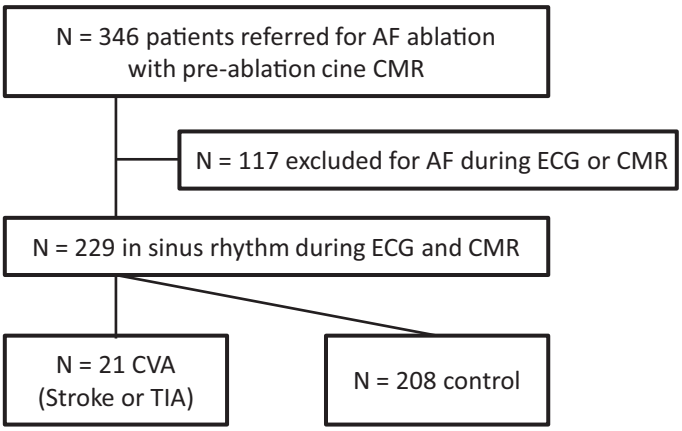

Figure 1. Patient enrollment. AF = atrial fibrillation; CMR = cardiac magnetic resonance; CVA = cerebrovascular accident; ECG = electrocardiogram; TIA = transient ischemic attack.

stroke or transient ischemic attack (TIA) before ECG or CMR; the remaining patients were designated as the control group (n = 208; 90.8%). The thromboembolic risk was assessed by the $CHADS_2$ and the CHA_2DS_2-VASc scores before development of CVA. The Johns Hopkins Institutional Review Board approved the study and all patients provided written informed consent.

The standard 12-lead ECG was recorded at rest by the Marquette MAC 5000 ECG system (GE Medical Systems, Milwaukee, Wisconsin) calibrated at 10 mm/mV with a speed of 25 mm/s. An experienced electrophysiologist, blinded to the group, made P-wave measurements manually from the ECG acquired immediately before CMR. $PTFV_1$ was defined as the absolute value of the depth (in millivolts) of the downward deflection (terminal portion) of the P wave (P′) in ECG lead V_1 multiplied by its duration (in milliseconds) (Figure 2).

CMR was performed using a 1.5-T magnetic resonance imaging scanner (Avanto and Aera, Siemens, Erlangen, Bavaria, Germany) equipped with a phased array cardiac coil. Vertical and horizontal long-axis cine CMR was performed using a steady-state free precession sequence (minimal repetition time/echo time, flip angle of 80°, an in-plane resolution of 1.4 × 1.4 mm, a slice thickness of 8 mm, and a spacing of 2 mm) with temporal resolution of 20 to 40 ms. We used off-line semiautomated multimodality tissue-tracking software version 6.0 (Toshiba, Tokyo, Japan) to analyze the LA and left ventricular (LV) structure and function in long-axis two- and four-chamber cine images.[5] The LA maximum and minimum volumes (V_{max} and V_{min}) were obtained from the phasic volume curve to calculate the following functional parameters: all the LA volumes were indexed by the body surface area. LA emptying fraction (EF) = $(V_{max} - V_{min}) \times 100\%/V_{max}$. In 229 patients included in the final analysis, 117 (51%, n = 13 in the CVA group and n = 104 in control group) also underwent late gadolinium enhancement (LGE) to quantify LA fibrosis as described previously.[6]

Continuous variables are presented as mean ± SD or median and interquartile range as appropriate. Categorical variables are presented as frequencies and percentages. Differences between group means were evaluated with

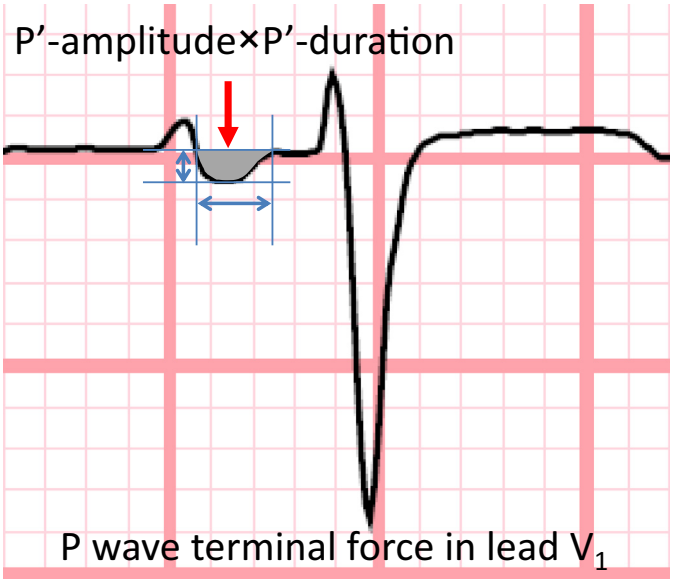

Figure 2. Illustration of components of P-wave terminal force in lead V_1 ($PTFV_1$). $PTFV_1$ is defined as the duration (in milliseconds) of the downward deflection (shaded gray area) of the P wave in lead V_1 multiplied by the absolute value of its amplitude (in microvolts).

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