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Original Article

Left atrial function, inflammation, and prothrombotic response after radiofrequency ablation for atrial fibrillation

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Abstract

Background: The conversion of atrial fibrillation (AF) to sinus rhythm is associated with transient dysfunction of the left atrium (LA). This study aimed to investigate the time course of LA function and inflammation after radiofrequency (RF) ablation for paroxysmal AF.
Methods: Fifty-three patients with paroxysmal AF undergoing RF ablation were recruited. White blood cells were counted and high-sensitivity C-reactive protein (hs-CRP), fibrinogen, and D-dimer levels were measured. LA emptying fraction, strain, and strain rate were evaluated before RF ablation and at 1, 2, 3, and 4 weeks and 2 and 3 months after ablation using conventional Doppler echocardiography and two-dimensional speckle-tracking echocardiography.
Results: LA emptying fraction sharply decreased at day 7 after ablation and then slowly increased ($p < 0.05$) and returned to the baseline value at day 28. LA strain and strain rate values sharply decreased at day 7 after the procedure and then slowly increased ($p < 0.05$). A significant correlation between hs-CRP level and LA emptying fraction was found at day 7.
Conclusion: Reduced LA function and increased prothrombotic tendency were found at ~1 week after AF ablation for paroxysmal AF. Therefore, monitoring the time and degree of anticoagulation after ablation for paroxysmal AF might effectively prevent thromboembolic events and reduce anticoagulant cost and bleeding risk.

Keywords: Atrial fibrillation; Catheter ablation; Inflammation; Left atrial function; Thrombosis

1. Introduction

Atrial fibrillation (AF) is a growing global health concern associated with an increased morbidity and mortality due to stroke and heart failure (HF), thus impairing quality of life. Radiofrequency (RF) ablation for AF, an important therapeutic modality for patients with AF, is known to cause an increase in several inflammation markers.[1,2] Inflammation is increasingly recognized to play a significant role in the genesis and perpetuation of AF.[3,4]

It is generally accepted that cardioversion of AF to sinus rhythm is associated with a reduction in left atrium (LA) and LA appendage blood flow velocity.[5,6] Patients with AF undergoing ablation are at increased risk of thromboembolic events, as well as atrial stunning, particularly in the first 2 weeks after the procedure, although the exact mechanisms are not known.[7] Results regarding the occurrence and duration of atrial stunning and the amount of anticoagulants after RF ablation for AF to effectively prevent thromboembolic events have differed.[3] At present, it is not known whether

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biochemical indicators of inflammation and blood clotting are related to the recovery of postoperative LA function.

The purpose of this study was to investigate the specific time course of LA function, inflammation, and prothrombotic response after RF ablation for paroxysmal AF using two-dimensional speckle-tracking echocardiography (2D-STE), which is a non−Doppler-based technique,[8] to help provide guidance in anticoagulation treatment decisions after RF ablation for AF.

2. Methods

2.1. Patients

Sixty consecutive patients aged less than 80 years experiencing paroxysmal AF who underwent circumferential pulmonary vein isolation (CPVI) were enrolled. Exclusion criteria were acute or chronic infection, left ventricular (LV) dysfunction, LA diameter >50 mm, atrial thrombosis, valvular heart disease, hyperthyroidism, previous prosthetic heart valve replacement, history of AF ablation, existing liver or kidney disease, malignant tumors, and any hematological system disease. The AF type was defined according to the Heart Rhythm Society expert consensus statement.[9]

2.2. Ablation procedure

Before the procedure, all patients underwent anticoagulation treatment with warfarin for 6 or more weeks to maintain their international normalized ratio between 2 and 3. Warfarin administration was stopped 7 days before the procedure and replaced with enoxaparin at a dose of 1 mg/kg twice a day, which was stopped at least 12 h before the operation. Transesophageal echocardiography was performed to exclude LA thrombus. All antiarrhythmic agents were ceased for 5 half-lives before the procedure.

All patients underwent CPVI performed using the same procedure, and no additional ablation was performed at the extrapulmonary sites unless atrial flutter was diagnosed before operation. All patients underwent pulmonary vein-LA reconstruction under computed tomography before the operation for a better illustration of the LA and pulmonary vein structures. The ablation catheter, after passing through the transseptal sheath, was inserted under pressure into the LA to perform RF ablation, and the procedure was monitored using a three-dimensional electro-anatomical mapping system (Carto 3; Biosense Webster). The mapping catheter for the circumferential pulmonary vein was used to record pulmonary vein potentials before, during, and after circumferential pulmonary vein ablation (Lasso® NAV Eco; Biosense Webster). The default strategy was to create a circle surrounding the two ipsilateral pulmonary veins. The operative endpoint was the entrance and exit block of the pulmonary vein potentials. Monitoring was carried out for 20−30 min after the entrance and exit block of the pulmonary vein potentials. Pulmonary vein potential conduction was detected again and, in case of recovery, ablation was carried out continuously.

2.3. Blood collection

Peripheral blood samples were collected for a total white cell count (WCC) and measurement of high-sensitivity C-reactive protein (hs-CRP), fibrinogen, and D-dimer levels before the operation and at 1, 2, and 3 days; 1, 2, 3, and 4 weeks; and 2 and 3 months after the operation. Samples were analyzed immediately.

The total WCC was evaluated using Sysmex XN2000 (Sysmex, Kobe, Japan). The hs-CRP was analyzed using an immunoturbidimetric latex CRP assay (LABOS PECT 008AS; Hitachi, Osaka, Japan). Fibrinogen and D-dimer were evaluated using the STAR coagulation analyzer (ACLTOP700; Beckman Coulter, Chaska, MN, USA). Normal reference ranges were the following: WCC, 3.5−9.5 ($\times 10^9$/L); hs-CRP, lower limit of detection 0.08 mg/L; fibrinogen, 2.38−4.98 g/L; and D-dimer, 0−0.232 mg/L.

2.4. Echocardiographic assessment

Echocardiography was performed preoperatively, at 1, 2, 3, and 4 weeks and 2 and 3 months postoperatively using a commercially available echocardiographic system (iE33 machines equipped with X3; Philips Medical Systems, Eindhoven, Netherlands). All parameters were analyzed by one experienced echocardiographer using QLAB software (version 9.0; Philips Medical Systems). The LV ejection fraction was assessed using the biplane Simpson disk method.[10]

In the parasternal long-axis views, the LA maximum anteroposterior diameter was measured. In the apical four-chamber view, the LA maximum volume at the end of LV systole, just before the opening of the mitral valve, and the LA minimum volume at the end of LV diastole, just after the closure of the mitral valve, were measured.[11] The LA emptying fraction was calculated as follows ([LA maximum volume - LA minimum volume]/LA maximum volume) × 100. The LA maximum volume was also measured using the biplane area-length method.[12]

Early (E) and late (A) diastolic filling velocities were measured using pulsed-wave Doppler at the mitral valve leaflet tips. For tissue Doppler imaging (TDI), the peak early diastolic tissue velocity (E′) was recorded from a four-chamber view at the lateral and septal border of the mitral annulus. The septal and lateral measures were averaged according to previous reports.[13]

2.5. Speckle tracking

Longitudinal LA strain was evaluated using speckle-tracking echocardiography (two-dimensional cardiac performance analysis; QLAB software; Philips Medical Systems).

The data from 12 LA segments (mid, annular, and superior segments along the lateral, septal, inferior, and anterior LA walls using apical four-chamber and two-chamber images) were averaged to determine the global LA peak systolic strain (εP) during LV ejection (LA reservoir phase). The peak strain rate (SR_P) was measured during LV ejection (LA reservoir

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