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Original Article

Radiofrequency catheter ablation is effective for atrial fibrillation patients with hypertrophic cardiomyopathy by decreasing left atrial pressure

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ABSTRACT

Background: Radiofrequency catheter ablation (RFCA) for atrial fibrillation (AF) refractory to medical therapy remains controversial in patients with hypertrophic cardiomyopathy (HCM); the acute effects on the direct left atrial (LA) pressure are not completely understood.
Methods: We consecutively studied patients with HCM ($n=15$) and without HCM (NHCM, $n=106$) who underwent extensive encircling pulmonary vein isolation for drug-refractory AF. We compared clinical parameters, echocardiographic parameters, electrophysiological parameters, LA pressures using hemodynamic catheterization and recurrence rate in both groups.
Results: The LA volume index was significantly higher (51.9 ± 13.6 mL/m^2 vs. 41.6 ± 12.7 mL/m^2, $p=0.02$) in the HCM group than the NHCM group. The pre-ablation mean LA pressure was significantly higher in the HCM group than the NHCM group. Among the AF patients, the mean LA pressure decreased more significantly in the HCM group than the NHCM group (post-ablation minus pre-ablation pressures: 4.2 ± 3.7 mmHg vs. 0.9 ± 4.1 mmHg, $p=0.03$). The early recurrence rate (within 30 days after ablation) tended to be higher in the HCM group than the NHCM group (20% vs. 5.7%, $p=0.08$), but the rates of late recurrences (>30 days after ablation) were similar (13.3% vs. 7.6%, $p=0.83$). Discontinuation of antiarrhythmic drugs occurred at rates of 13% and 62% in the HCM and NHCM groups, respectively ($p<0.001$).
Conclusions: The LA pressure in the HCM group decreased immediately after AF RFCA. Patients with HCM and drug-refractory AF may benefit from RFCA.

1. Introduction

Atrial fibrillation (AF) is a common complication in patients with hypertrophic cardiomyopathy (HCM), occurring at a prevalence greater than 20% [1]. When AF is refractory to medical therapy in these patients, it is associated with a worse clinical status and a significant increase in the risk of stroke, heart failure, and death [2]. Moreover, maintaining long-term sinus rhythm with antiarrhythmic drug (AAD) therapy alone is often difficult in HCM because the associated diastolic dysfunction facilitates increased left atrial (LA) pressures and exacerbates LA remodeling, eventually leading to further AF [3].

Radiofrequency catheter ablation (RFCA) has recently emerged as an important non-pharmacological treatment for AF. However, the maintenance of sinus rhythm after RFCA is considered difficult because of the left ventricular diastolic dysfunction in HCM. Consequently, whether or not RFCA leads to favorable outcomes remains controversial [4,5]. We evaluated the long-term efficacy of extensive encircling pulmonary vein isolation (EEPVI) for drug-refractory AF in HCM patients. Furthermore, we investigated the acute effects of the direct LA pressure in patients with HCM and without HCM (NHCM).

2. Materials and methods

2.1. Study population

Patients from Hiroshima University Hospital were retrospectively included. We included 15 patients with HCM who underwent their first session of RFCA for drug-refractory symptomatic AF between January 2009 and January 2013. No patient with HCM underwent additional substrate modification beyond EEPVI. We included 173 patients without HCM who underwent their first session of RFCA for drug-refractory symptomatic AF between January 2011 and December 2011. We excluded patients

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with severe valvular disease ($n=10$), congenital heart disease ($n=1$), left ventricular ejection fraction $\leq 40\%$ ($n=10$), old myocardial infarction ($n=3$), or those who were on long-term hemodialysis ($n=2$). We also excluded patients who underwent additional substrate modification beyond EEPVI (e.g., superior vena cava isolation, $n=10$; roof line ablation, $n=24$; and mitral annulus ablation, $n=7$). Finally, we enrolled 121 patients who were divided as follows: 15 patients with HCM (HCM group, 12 male patients, 62 ± 8 years of age) and 106 patients without HCM (NHCM group, 82 male patients, 61 ± 9 years of age). HCM was diagnosed based on two-dimensional echocardiographic evidence of a hypertrophied, non-dilated left ventricle (LV maximum wall thickness ≥ 15 mm) in the absence of any other cardiac or systemic disease capable of producing an evident magnitude of hypertrophy [6]. Paroxysmal AF was defined as recurrent AF (>2 episodes) that spontaneously terminated within 7 days. Persistent AF was defined as AF that was sustained beyond 7 days or lasted <7 days but necessitated pharmacological or electrical cardioversion. Longstanding persistent AF was defined as continuous AF with a duration >1 year [7]. This study was approved by the ethical committee of Hiroshima University Graduate School of Biomedical and Health Sciences.

2.2. Echocardiography

Transesophageal and transthoracic echocardiography were performed within 24 h before ablation to exclude the presence of an LA thrombus or structural heart disease, using commercially available ultrasonographic systems (iE33; Philips Medical Systems, Best, The Netherlands). Echocardiography measurements were taken in accordance with the recommendations of the American Society of Echocardiography.

2.3. Electrophysiological study and RFCA

Patients were treated with warfarin for at least 1 month before the procedure and throughout the periprocedural period, without interruption, maintaining a prothrombin time–international normalized ratio of 2.0–3.0. AADs such as β-blockers, but excluding amiodarone, were stopped at least five half-lives before the procedure. Amiodarone was routinely discontinued at least 2 weeks prior to the procedure.

EEPVI and bidirectional cavotricuspid isthmus blocks were performed, as reported previously [8]. After two circular mapping catheters (Lasso; Biosense Webster, Diamond Bar, CA, USA) were positioned within the ipsilateral superior and inferior pulmonary veins (PVs) under the guidance of selective PV angiography, continuous EEPVI was performed during the first ablation to achieve electrical isolation of the left- and right-sided PVs (in pairs); EEPVI was performed 0.5–2 cm from the PV ostia, as defined by PV angiography and a three-dimensional electro-anatomical mapping system (CARTO3; Biosense Webster) with computed tomography integration (CARTOMERGE; Biosense Webster). At the anterior aspect of the left PVs, ablation was attempted along the ridge between the LA appendage (LAA) and PV ostia. EEPVI was performed using an irrigated 3.5-mm tip electrode catheter (THERMOCOOL; Biosense Webster). Radiofrequency energy was delivered for 15–20 s at each point around EEPVI line to achieve a reduction in the amplitude of the local bipolar atrial electrogram of $>80\%$ or <0.1 mV. If AF persisted after completion of EEPVI line, cardioversion was performed to restore sinus rhythm. Successful PV isolation was defined as the loss of all PV potentials (entrance block) and failure to capture the LA when pacing from the PV (output 10 mA; pulse width 2 ms; exit block) using circular multipolar mapping catheters. These maneuvers were repeated after 20–60 min to exclude acute PV reconnections. We performed only EEPVI or trigger-based RFCA in the first session because there was no useful evidence of effective additional substrate modification beyond EEPVI. For patients who recurred after EEPVI without reconnection of the PV or the other PV foci, we performed additional substrate modification beyond EEPVI. These patients were excluded from this study.

We performed a bidirectional cavotricuspid isthmus block with an endpoint of bidirectional conduction block in all patients following EEPVI. After stable sinus rhythm, an electrophysiological study was performed (within 1 h). AA (onset or peak of one atrial signal to the same aspect of the next consecutive signal), AH (atrial signal to the His bundle), and HV (His bundle to the first ventricular activation) intervals were measured. The corrected sinus node recovery time (cSNRT) was defined as the recovery interval in excess of the sinus cycle (i.e., cSNRT = max SNRT − sinus cycle length). Significant ablation-related complications were considered to include the following: death, stroke, peripheral emboli, cardiac tamponade or perforations, valvular damage, arteriovenous fistulae requiring surgical intervention, and a large vascular access-site hematoma resulting in a drop in the hemoglobin level by 20 g/L.

2.4. Measurement of LA, right atrium, and arterial pressures

All patients were prohibited from eating and drinking for 12 h before ablation. They were infused with 500 mL of normal saline solution 3 h before the ablation; the infusion was maintained at a rate of 20 mL/h during the ablation. No diuretics were used. The LA, right atrium (RA), and arterial pressures were measured using a water-filled system at two time points (i.e., just after the transseptal puncture and after completion of the EEPVI). Mean values were obtained by averaging at least three beats.

2.5. Follow-up

Patients were restarted on suitable AADs prior to discharge according to the results of the electrophysiological study. The primary endpoint was to assess the maintenance of sinus rhythm regardless of whether they were taking AADs or not. In HCM patients, AADs were continued regardless of whether the arrhythmia recurred. Each patient was followed by clinic visits with 12-lead electrocardiogram, echocardiography, and 24-hour

Table 1A
Clinical characteristics.

	NHCM group ($n=106$)	HCM group ($n=15$)	p Value
Age (years)	61 ± 9	62 ± 8	0.88
Male	82 (77%)	12 (80%)	0.82
AF type (paroxysmal, persistent, long)	68/18/19	9/4/2	0.66
Duration of AF (months)	26 (8-52)	36 (6-60)	0.69
Hypertension	50 (47%)	7 (46%)	0.97
Diabetes mellitus	18 (17%)	2 (13%)	0.72
Dyslipidemia	31 (30%)	3 (20%)	0.44
Body mass index (kg/m^3)	23 ± 3	26 ± 4	<0.01
Current smoker	14 (13%)	3 (20%)	0.51
Procedure duration (h)	3.5 ± 0.7	4.3 ± 1.2	0.01
eGFR $<$ 60 mL/min per 1.73 m^2	19 (18%)	6 (40%)	0.06
Medications before RFCA			
Class I AADs	32 (31%)	7 (46%)	0.23
Amiodarone	17 (16%)	5 (33%)	0.14
Bepridil	11 (11%)	1 (6%)	0.64
β-blocker	28 (27%)	9 (60%)	0.01

AF, atrial fibrillation; eGFR, estimated glomerular filtration rate; RFCA, radiofrequency catheter ablation; AADs, antiarrhythmic drugs.
Values are expressed as mean (standard deviation) or median (inter-quartile range) or absolute number of cases (relative percentage) as appropriate. p Values were two-tailed, and $p<0.05$ was considered statistically significant.

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