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Original Article

Effects of two kinds of radio frequency ablations on morphology and function of left atrium in patients with atrial fibrillation

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Abstract: Objective: This study aims to observe the effects of circumferential pulmonary vein ablation (CPVA) and CPVA combined with complex fractionated atrial electro-gram (CPVA+CFAE) on morphology and function of left atrium in patients with atrial fibrillation (AF). Methods: To evaluate the effects of CPVA and CPVA+CFAE on morphology and function of left atrium, the left atrial volume and late diastolic velocity peak (Va) were determined by tissue Doppler imaging before and after CPVA and CPVA+CFAE, respectively. Results: There was no statistical difference in the left atrial volume before and after CPVA. However, Va was significantly higher after CPVA (P=0.001). There was no statistical difference in both the left atrial volume and Va before and after CPVA+CFAE. Va after ablation was significantly higher in CPVA group than in CPVA+CFAE group (P=0.031). Conclusion: The left atrial function was significantly improved after CPVA, but CPVA+CFAE failed to markedly improve the left atrial function. This suggests that excessive atrial substrate ablation may damage the left atrial function.

Keywords: Atrial fibrillation, radiofrequency ablation, atrial substrate

Introduction

Atrial fibrillation (AF) is the most common tachyarrhythmia [1]. Its prevalence rate is 3-5% in population older than 65 years and 9% in population older than 80 years [2]. AF is an independent risk factor for cerebral stroke and heart failure because it is associated with 20% of cerebral stroke and 30% of heart failure and it allows mortality of patients to increase by 2 times [3]. AF is mainly related to trigger factors and atrial substrate. Radiofrequency catheter ablation treats AF through isolating the trigger factors or interfering with atrial substrate [4, 5]. There has not been a definite schema of radiofrequency catheter ablation for AF, but its overall recurrence rate is about 20-60% [6-8]. The aim of this study was to provide a basis for AF ablation strategies by observing changes in the left atrial volume and late diastolic velocity peak (Va) before and after ablation and comparing effects of two different ablation schemas on morphology and function of left atrium.

Subjects and methods

All study methods were approved by the Ethics Committee of the First Affiliated Hospital of Soochow University. All the subjects enrolled into the study gave written formal consent to participate.

Subjects

AF radiofrequency catheter ablation was suitable for the patients who had symptomatic AF, or AF-induced heart failure or low cardiac output due to no response to class I or III antiarrhythmic agents or intolerable adverse effects to these drugs. The patients with left atrial thrombosis identified by transesophageal echocardiography, and the patients undergoing the second ablation due to AF recurrence or new atrial tachycardia after the first ablation, were excluded from this study.

A total of 76 cases consistent with inclusion criteria were enrolled in this study. Of the 76

Table 1. General information of patients in CPVA and CPVA+CFAE group

	CPVA group	CPVA+CFAE group	*F* values	*P* values
Sex (male/female, n)	23/10	30/13	0.000	0.995
Age (year)	57.48±9.543	60.79±9.078	2.368	0.128
Body height (cm)	165.88±8.065	165.02±5.087	0.319	0.574
Body weight (kg)	69.80±10.50	69.24±8.199	0.066	0.797
Blood-fasting sugar	5.849±1.470	5.763±0.922	0.097	0.756
LDL-C	2.718±0.821	2.482±0.646	1.975	0.164
BNP	347.09±376.96	474.42±495.84	1.507	0.223
PLAV (cm^3)	46.18±9.432	45.23±7.476	0.240	0.626
PCP	133.18±26.025	142.02±26.8	2.084	0.153
PDP	82.88±14.411	83.28±12.372	0.017	0.897
Blood sedimentation	7.03±7.880	7.44±5.147	0.076	0.784
Pre-ablation Va (cm/s)	7.470±1.224	7.314±1.086	0.344	0.559

Notes: CPVA: circumferential pulmonary vein ablation; CPVA+CFAE: CPVA combined with complex fractionated atrial electro-gram; LDL: Low density lipoprotein; BNP: brain natriuretic peptide; PLAV: pre-ablation left atrial volume; PCP: pre-ablation contractive pressure; PDP: pre-ablation diastolic pressure; Va: late diastolic velocity peak.

cases, 53 were man and 23 women, with a mean age of 59.36±9.366 years. They had a mean stature of 165.4±6.514 cm, a mean weight of 69.5±9.207 kg, a mean pre-ablation left atrial volume of 45.6±8.336 cm^3 and a mean pre-ablation Va of 7.382±1.143 cm/s.

Grouping

The 76 cases were divided two groups using Excel random number function in mathematics. The two groups were circumferential pulmonary vein ablation group (CPVA group) and CPVA combined with complex fractionated atrial electro-gram group (CPVA+CFAE group). CPVA group consisted of 33 cases including 23 men and 10 women with a mean age of 57.48±9.543 years. CPVA+CFAE group consisted of 43 cases including 30 men and 13 women with a mean age of 60.79±9.078 years (**Table 1**).

CPVA procedures

a) Interatrial septum puncture: The sheathing canal (8.5FSWARTL1, ST Jude) was introduced into superior vena cava using 145 cm-long guidewire with a diameter 0.032 inches. After pulling out the guidewire, a puncture needle was placed into the sheath canal and positioned 2 cm away from the top of the sheathing canal. Adjusting puncture device allowed the headend of vagina interna to slide to fossa ovalis. The puncture device was vertically towards the interatrial septum, and then puncture was performed followed by confirmation through injection of contrast agent. Lasso mapping electrode was introduced into the ostium of the left superior pulmonary vein.

b) After second interatrial septum puncture (as the same procedures above), the left and right pulmonary phlebography was performed by injecting contrast agent.

c) Ostia of pulmonary veins identified by CARTO system: The ostia of the left and right pulmonary veins were identified by pulmonary phlebography combined with CARTO system.

d) Ablation from one point to another point around the left (and right) superior and inferior pulmonary veins: The complete electrical isolation between pulmonary veins and the left atrium was judged according to atrial pacing and pulmonary vein pacing. If complete electrical isolation failed to be achieved, ablation was performed again on the gap of original ablation path until the elimination of pulmonary vein potentials.

e) Those patients who had persistent AF or AF attack during ablation were converted to sinus rhythm by intravenous ibutilide (one milligram) or direct current cardioversion.

CPVA+CFAE procedures

Steps a), b), c) and d) were the same as the steps above.

e) Further finding fragmented potential zone in heart atrium followed by ablation: CARTO system automatically determined the fragmented potential. Software could continuously record low-amplitude fragmentation wave (0.05-0.15 mV) during 2.5 s and calculate interval confidence level (ICL) and shortest complex interval (SCI), which were displayed in three-dimensional structure chart of the left atrium.

f) Those patients who had persistent AF or AF attack during ablation were converted to sinus

Table 2. Comparisons of left atrial volume and Va between before and after ablation within groups

		Pre-ablation	Post-ablation	*F* values	*P* values
CPVA group	left atrial volume (cm^3)	46.18±9.432	43.21±15.471	0.020	0.984
	Va (cm/s)	7.470±1.224	8.061±1.1643	3.552	0.001
CPVA+CFAE group	left atrial volume (cm^3)	45.23±7.476	46.14±12.047	0.665	0.509
	Va (cm/s)	7.314±1.086	7.512±1.003	1.586	0.123

Notes: CPVA: circumferential pulmonary vein ablation; CPVA+CFAE: CPVA combined with complex fractionated atrial electrogram; Va: late diastolic velocity peak.

Table 3. Comparisons of post-ablation recurrence rate, new atrial tachycardia rate, left atrial volume and Va between CPVA group and CPVA+CFAE group

	CPVA group	CPVA+CAFE group	*F* values	*P* values
Recurrence rate (n, %)	6 (18.18%)	6 (13.95%)	2.713	0.104
New atrial tachycardia rate (n, %)	4 (12.12%)	5 (11.63%)	0.017	0.897
Left atrial volume (cm^3)	46.21±15.471	46.14±12.047	0.001	0.982
Va (cm/s)	8.061±1.1643	7.512±1.003	4.863	0.031

Notes: CPVA: circumferential pulmonary vein ablation; CPVA+CFAE: CPVA combined with complex fractionated atrial electro-gram; Va: late diastolic velocity peak.

rhythm by intravenous ibutilide (one milligram) or direct current cardioversion.

Echocardiogram

The left atrial volume and Va were determined by tissue Doppler imaging (PHLIPS iE33 5.1.0.206).

Pre and post-ablation management

Pre-ablation oral warfarin for 3 weeks maintained international normalized ratio (INR) at 2.0-3.0. Post-ablation oral warfarin for 2-3 months maintained INR at 2.0-3.0. Propafenone or amiodarone were taken if AF or atrial tachycardia occurred within 3 months after ablation. The treatment for primary disease was normally carried out.

Follow-up after ablation

Patients underwent ECG and 24-hour Holter-ECG, and patients' left atrial volume and Va were determined 6 months after ablation. If patients had AF after ablation, it was regarded as AF recurrence. If patients had got no atrial tachycardia before ablation, but they had it after ablation, which was regarded as new atrial tachycardia.

Statistical analysis

Measurement data were expressed as mean ± standard deviation ($\bar{X}\pm s$). *t* test was used in comparison of mean. x^2 test was used in comparison of percentage. Statistical treatment was performed using SPSS-13.0 software. Statistical significance was established at $P<0.05$.

Results

The 76 cases underwent ablation, and they all had no complications such as pneumothorax, cardiac tamponade, thrombembolia, pulmonary vein stenosis and atrial esophageal fistula. There was no statistical difference in the left atrial volume between before and after CPVA, but Va was significantly higher after CPVA than before CPVA (P=0.001). There was no statistical difference in both the left atrial volume and Va between before and after CPVA+CFAE (**Table 2**). During the follow-up of 15±5.5 months (range 6-24 months), AF recurred in 6 cases of both groups, and new atrial tachycardia occurred in 4 cases of CPVA group and in 5cases of CPVA+CFAE group. There was no statistical difference in AF recurrence rate and new atrial tachycardia rate between the two groups. There was no statistical difference in atrial volume between the two groups after ablation, but Va was significantly higher in CPVA than in CPVA+CFAE after ablation (P=0.031) (**Table 3**).

Discussion

CPVA can achieve electrical isolation between the left atrium and pulmonary vein, namely that it can isolate trigger factors of AF. Based on CPAV, CVPA+CFAE also interfere with atrial substrate. In theory, atrial substrate ablation is more; the possibility of AF recurrence is less. However, atrial substrate ablation is a double-edged sword. Excessive atrial substrate abla-

tion may damage the left atrial function and increase post-ablation new atrial tachycardia rate [9, 10] and post-ablation complication rate [11, 12]. In this study, post-ablation AF recurrence rate was higher in CPVA group than in CPVA+CFAE group, bur there was no statistical difference in AF recurrence rate between the two groups. post-ablation new atrial tachycardia rate was lower in CPVA group than in CPVA+CFAE group, bur there was also no statistical difference in new atrial tachycardia rate between the two groups. Our results were not consistent with the results reported by Lin [13]. This may be that the small sample in this study is not enough to show statistical difference.

Va value can reflect atrial systolic function. Atrial substrate remodeling after AF ablation affects left atrial function [14, 15]. This study indicated that post-ablation Va value was significantly higher than pre-ablation Va value in CPVA group, and post- ablation Va value was significantly higher in CPVA group than in CPVA+CFAE group. These results suggest that appropriate ablation can improve left atrial systolic function, but excessive atrial substrate ablation fails to improve left atrial systolic function. We infer that in CPVA group, based on the elimination of AF, the left atrial function is improved due to no excessive intervention in the left atrial substrate; but in CPVA+CFAE group, although AF is also cured, the left atrial function fails to be improved due to excessive intervention in the left atrial substrate. Therefore, we believe that excessive ablation does not necessary improve clinical outcome in the patients with AF.

In summary, in AF ablation, under the condition that AF is cured, the area of atrial substrate ablation should be reduced as much as possible.

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Disclosure of conflict of interest

None.

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