Clinical characteristics and electrophysiological features in patients with persistent atrial fibrillation undergoing radiofrequency energy ablation

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Summary

Objective: To investigate the clinical and paraclinical characteristics and electrophysiological features after cardioversion in patients with persistent atrial fibrillation (AF). *Subejct and method:* This was a prospective study of 40 patients with persistent AF who underwent catheter ablation of AF using a three-dimensional (3D) system at the Vietnam Heart Institute, Bach Mai Hospital. *Result*: The mean age of the patients was 54.25 ± 12.54 years, and 80% of patients were male, the symptoms (according to EHRA) of patients ranged from grade IIb (67.5%) to grade III (32.5%). Hypertension (42.5%) and alcohol abuse (37.5%) were the most common risk factors. After cardioversion, patients with persistent AF exhibited longer sinus node recovery time (SNRT) (1445.11 ± 547.33ms) and corrected SNRT (667.03 ± 517.21ms) than healthy controls. *Conclusion*: Persistent AF is common in the elderly, especially men, with prevalent risk factors, such as hypertension and alcohol abuse. After cardioversion, patients with persistent AF have an SNRT longer than normal.

Keywords: Persistent atrial fibrillation, electrophysiology, ablation, sinus rhythm recovery.

1. Background

Atrial fibrillation (AF) is a common arrhythmia, whose treatment requires significant attention. The risk of AF increases with age and cardiovascular diseases. In 2016, there were 43.6 million AF patients worldwide, 37% of whom were aged > 55 years and living in Europe/were Europeans aged > 55 years [1]. Several achievements in AF ablation have helped patients recover fom sinus rhythm. In Vietnam, Linh et al (2015) performed ablation for 40 patients with paroxysmal AF and obtained good results. Despite those successes, we have not conducted a trial focusing on ablation for patients with persistent AF in Vietnam. This study aimed to determine the clinical characteristics and electrophysiological features after sinus rhythm recovery in patients with persistent AF who underwent radiofrequency energy ablation.

2. Subject and method

Study design: A prospective interventional study using a convenient sample size.

Study contents: 40 patients with persistent AF underwent AF ablation using a 3D mapping system (EnSite Precision) at the Vietnam National Heart Institute, Bach Mai Hospital, from October 2017 to November 2021.

Inclusion criteria: Persistent AF: Record on 12-lead ECG, maintaining for > 7 days. Symptomatic patients despite medical treatment and accepting AF ablation. No severe stenosis or valvular regurgitation indicative of intervention or operation.

Received: *10 October 2022,* ***Accepted***: *29 December 2022*
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No ischemic heart disease indicative of revascularization.

Exclusion criteria: Thrombus in the heart chamber. Elderly patients (age ≥ 80 years). Heart failure with reduced ejection fraction (EF < 45%). Basedow's disease. Blood clotting disorder.

Study protocol: All patients underwent clinical evaluation of symtoms, medical history, blood tesst, echocardiography, MSCT for left atrium and pulmonary veins. All patients underwent pulmonary vein isolations (PVI) and cardioversion to sinus rhythm. Any arrhythmias such as premature atrial complexes, atrial flutter or atrial tachycardia were noted. Peak to peak map were used to define low voltage zone in left atrial (cut off 0.2 - 0.5mv). Measure the basic intervals in sinus rhythm: PA, AH, HV, QRS and QT. Incremental pacing and extra stimulus pacing to define effective refractory period of atrial, ventricular, atrial - ventricular node function.

Diagnostic criteria: Hypertension followed ECS 2018 guidelines. Diabetes followed ADA 107 guidelines. Excessive smoking consumption followed WHO 1996. Excessive alcohol consumption followed CDC USA.

Measurement criteria: Left atrial diameter were measured in 2D cardiac echo long-axis cross sectional. Pulmonary vein's diameter on MSCT were measured at antrums.

Statistical analysis: Data were analyzed using IBM SPSS 21.0 software. The *t*-test was used to compare two mean values, and the chi-square test ($\chi 2$) was used to compare two percentages. p-value<0.05 was considered statistically significant.

3. Result

3.1. General characteristics of patients with persistent AF

The study included 32 male (80%) and 8 female (20%) patients, with a mean age of 54.25 ± 12.54 years (23-72). There were 12 young patients (aged < 50 years), 12 patients aged 50-59 years, and 16 older patients (aged ≥ 60 years). All patients were symptomatic before ablation. According to the European Heart Rhythm Association (EHRA) score, 67.5% were grade IIb and the rest were grade III. In our study, hypertension (17/40 cases) and excessive alcohol consumption (15/40) were two common risk factors.

Table 1. Clinical characteristics of patients

	Mean	Range
Weight (kg)	65.18 ± 12.66	44-107
Height (m)	1.65 ± 0.7	1.5-1.79
BMI (kg/m^2)	23.63 ± 3.09	18.8-34.9
Heart rate (bpm)	89.53 ± 19.78	67-150
Systolic blood pressure (mmHg)	127.6 ± 21.37	90-200
Diastolic blood pressure (mmHg)	80.38 ± 12.83	60-120
Time from AF diagnosis (months)	14.37 ± 15.53	0.25-72
Dd (mm)	46.29 ± 5.89	32-65
Ds (mm)	29.82 ± 5.41	17-49
LVEF (%)	64.89 ± 7.0	50-79
Left atrium (mm)	38.39 ± 6.12	31-55
Pulmonary artery pressure (mmHg)	30.67 ± 5.54	21-46
Grade of MVR	0.87 ± 0.62	0-2
Grade of TVR	1.08 ± 0.36	1-3

Fourteen patients (35%) had left atrial enlargement on 2D echo with a mean diameter of 44.71 ± 4.25mm.

The diameters of pulmonary veins were measured using MSCT. The mean diameters of the left superior pulmonary vein (LSPV), left inferior pulmonary vein (LIPV), right superior pulmonary vein (RSPV), and right inferior pulmonary vein (RIPV) were 18.02 ± 4.08, 15.68 ± 4.43, 17.98 ± 4.35, and 16.21 ± 4.16mm, respectively. Our patients' LSPVs, LIPVs, and RSPVs had an electronic connection to the left atrial. Only four RIPVs (10%) had no electronic connection to the left atrial.

3.2. Electrophysiological features after sinus rhythm recovery

Table 2. Basic intervals after sinus recovery

Basic intervals	< 60 years (n = 23)	≥ 60 years (n = 12)	p	Overall (n = 35)
Basic cycle length (ms)	841.92 ± 185.19	821.08 ± 168.66	0.708	834.97 ± 177.7
PA (ms)	37.61 ± 12.56	29.45 ± 17.08	0.282	34.97 ± 14.44
AH (ms)	99.7 ± 32.94	106.0 ± 32.45	0.917	101.86 ± 32.43
HV (ms)	56.43 ± 8.8	60.67 ± 10.14	0.316	57.89 ± 9.36
QRS (ms)	86.74 ± 16.09	82.73 ± 20.63	0.98	85.44 ± 17.47
QT interval (ms)	377.87 ± 39.88	387.67 ± 50.33	0.602	381.23 ± 43.26

Table 2 shows that the basic intervals after sinus rhythm recovery were within the normal range. No significant difference was observed between the two groups below and patients older than 60 years.

Table 3. Sinus node recovery time (SNRT)

Stimulation cycle length	SNRT (ms)
500ms	1,235.0 ± 325.62
400ms	1,291.89 ± 276.63
330ms	1,445.11 ± 547.33
Corrected SNRT (ms): 667.03 ± 517.21	

Table 3 shows that the SNRT and corrected SNRT were significantly longer in our patients than normal. The SNRT was the longest at the stimulation cycle length of 330ms.

Table 4. Effective refractory period of atrial, ventricular, and AV nodes

	Atrial ERP (ms)	Ventricular ERP (ms)	Anterograde AVN ERP (ms)	Wenckebach anterograde AVN (ms)	Retrograde AVN ERP (ms)	Wenckebach retrograde AVN (ms)
< 60 years[1]	224.29 ± 19.38	234.55 ± 17.65	330.95 ± 73.61	422.63 ± 67.07	372.5 ± 123.66 (n = 7)*	441.43 ± 92.09 (n = 7)*
≥ 60 years[2]	220.0 ± 12.47 (*n* = 11)	234.55 ± 15.08 (*n* = 11)	350.91 ± 95.65 (*n* = 11)	437.5 ± 90.16 (*n* = 11)	380.0 ± 28.28 (*n* = 2)*	450.0 ± 0.0 (*n* = 2)*
Overall	222.9 ± 17.36	234.55 ± 16.6	337.81 ± 80.87	428.39 ± 75.72	375.0 ± 96.69	443.33 ± 79.84
p[1,2]	*0.92*	*0.689*	*0.49*	*0.916*	*0.915*	*0.873*

ERP: Effective refractory period. AVN: atrial ventricular node.

**Only calculated if the AVN of patients had retrograde transmission function.*

The atrial stimulation limit was set at 220ms to prevent nonclinical-induced atrial arrhythmias.

4. Discussion

4.1. Clinical characteristics of persistent AF

The mean age in our study was higher than that in other studies on arrhythmias in Vietnam [2]. However, it was similar to Moussa Mansour's study (2020) on patients with persistent AF (65.4 ± 8.8 years). AF and persistent AF increase with age and are more common in males. According to a previous trial, AF will predominate in males > 50 years. The mean BMI was 23.63 ± 3.09, indicating overweight. Tsang et al [3] and Sandhu et al [4] demonstrated that obesity is closely associated with and accelerates AF progression.

Hypertension was the most common risk factor in our study, similar to that in other trials around the world. Ogunsua et al [5] (2015) statistics showed that hypertension increases the risk of developing new AF by 1.8 times and increases the risk of progression from paroxysmal to persistent AF by 1.5 times. Hypertension causes fibrosis and dilation of the heart chambers. The renin angiotensin mechanism is significant in the pathology of hypertension and the formation of AF. Excessive alcohol consumption is the second most common risk factor (37.5%). Voskoboinik et al. (2020) reported that alcohol abuse is closely related to the risk of developing AF; up to 35% of patients develop AF because of alcohol abuse [6]. Alcohol abuse affects the autonomic and sympathetic nervous systems, reduces heart rate variability, and is associated with acute inflammation of particular myocardial regions. Moreover, excessive alcohol consumption causes dilation of the left atrium, resulting in impaired atrial muscle function, substrate, and electrical power. It is also associated with a subsequent increase in blood pressure.

Fourteen patients (35%) had left atrial enlargement on 2D echo with a mean diameter of 44.71 ± 4.25mm. This study is the first to investigate persistent AF ablation in Vietnam. Therefore, we chose patients with quite small left atrial diameters to achieve a higher success rate.

The size and diameter of PVs in our study were similar to those of Linh et al. and Scharf et al[7]. No patient had a common trunk of the pulmonary vein, and no patient had a branch of the middle pulmonary vein. Other studies have noted these anatomical variations, such as Prasanna et al [8], in which 12% had a right middle pulmonary vein branch and 4% had a left common pulmonary trunk. Shah et al (2000) noted that when performing electrophysiological exploration in 225 patients with AF refractory to drug therapy, up to 96% of the ectopic foci originated from the pulmonary veins [9], of which up to more than half of the patients had onset in the LSPV. They are probably responsible for most peripheral foci causing AF [10].

4.2. Electrophysiological features after sinus rhythm recovery

All the basic intervals in our study were within the normal range. In addition, the SNRT in our study was longer than that in other studies because our patients received antiarrhythmic drugs until the time of ablation. These antiarrhythmic drugs prolonged the basic conduction interval in our patients compared to that in the abovementioned studies of normal subjects without antiarrhythmic drugs.

The effective refractory period of the atrial, ventricular, and Wenckebach time of the AV node was within the normal range. The proportion of the AV node retrograde transmission function differed significantly between reports (7%–18%). Our patients had fewer retrograde transmission functions because antiarrhythmic drugs were used to control the ventricular rate. Moreover, our patients were older than those in other studies, and the degeneration of the AV node could occur. According to our results, using antiarrhythmic drugs did not cause significant changes or negatively impact the electrophysiology functions of patients.

5. Conclusion

Patients with persistent AF have a mean age of 54.25 ± 12.54 years, with a statistically significantly higher proportion of males than females.

Hypertension and alcohol abuse are common risk factors for these patients. Patients with AF undergoing intervention had symptoms according to the EHRA score, mainly at levels IIb and III.

SNRT and corrected SNRT were longer in the group of patients with persistent AF after cardioversion compared to the other groups of normal patients.

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