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Risk of pacemaker implantation after uneventful successful cavotricuspid isthmus radiofrequency ablation in patients with common atrial flutter

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ABSTRACT

Introduction: Little is known about the risk of pacemaker implantation after common atrial flutter ablation in the long-term.
Methods: We retrospectively reviewed the electrophysiology laboratory database at two Spanish University Hospitals from 1998 to 2012 to identify patients who had undergone successful ablation for cavotricuspid dependent atrial flutter. Cox regression analysis was used to examine the risk of pacemaker implantation.
Results: A total of 298 patients were considered eligible for inclusion. The mean age of the enrolled patients was 65.7 ± 11. During 57.7 ± 42.8 months, 30 patients (10.1%) underwent pacemaker implantation. In the stepwise multivariate models only heart rate at the time of the ablation (OR: 0.96; 95% CI: 0.93–0.98; $p < 0.0001$) and intraventricular conduction disturbances in the baseline ECG (OR: 3.87; 95% CI: 1.54–9.70; $p = 0.004$) were independents predictors of the need of pacemaker implantation. A heart rate of ≤65 bpm was identified as the optimal cut-off value to predict the need of pacemaker implantation in the follow-up (sensitivity: 79%, specificity: 74%) by ROC curve analyses.
Conclusion: This is the first study of an association between the slow conducting common atrial flutter and subsequent risk of pacemaker implantation. In light of these findings, assessing it prior to ablation can be helpful for the risk stratification of sinus node disease or atrioventricular conduction disease requiring a pacemaker implantation in patients with persistent atrial flutter.

1. Introduction

Typical atrial flutter (AFL) is a common arrhythmia, representing about 10% of hospitalizations for supraventricular tachycardia in adults [1]. The reentrant circuit through the isthmus cavotricuspid (CTI) is located in the right atrium and the left atrium is then activated passively [2]. Therefore, radiofrequency (RF) ablation of atrial flutter appears as a reasonable approach regarding feasibility and effectiveness, and it is considered as a low procedural risk [3–7]. Most studies on ablation-related complications concern all indications of ablation, however, little is known about the risk of pacemaker implantation (PMI) after uneventful successful CTI ablation in the long term follow-up [8–10].

The purpose of the study was to assess the outcomes in terms of PMI and potential predictors after uneventful successful RF ablation procedure of typical AFL.

2. Methods

We retrospectively reviewed the electrophysiology laboratory database at two Spanish University Hospitals from 1998 to 2012 to identify patients who had undergone electrophysiology (EP) study for CTI dependent AFL. Eligible criteria included the following: (i) CTI participation in the arrhythmic circuit confirmed by an EP study, (ii) an atrial activation pattern during atrial tachycardia (AT) showing a clockwise or counterclockwise rotation around the tricuspid annulus (TA), (iii) termination of the AFL by a CTI linear ablation, and (iv) atrial flutter persisting for more than 2 weeks. Typical AFL was diagnosed when the surface ECG showed flutter waves that were pre-dominantly negative in leads II and III, and aVF and positive in lead V1, with a regular atrial rate [1]. However, patients with atypical flutter waves were not included in our study. Also, patients were excluded if they had previously undergone an AFL ablation or PMI for sinus node dysfunction disease (SND) or auriculoventricular (AV) conduction disease. Finally, patients who presented complete AVB occurring during ablation of atrial flutter by an inadvertent application of energy on the normal AV conduction system were excluded.

Ablation of AFL by RF was performed by the conventional method using a "HALO" catheter. Energy was delivered by a RF catheter 8 mm to use a maximum power of 70 W and a maximum target temperature of 60°. PR interval was registered in the entire

Abbreviations: AFL, atrial flutter; CTI, cavotricuspid isthmus; EPS, electrophysiology study; HR, heart rate; PMI, pacemaker implantation; RF, radiofrequency.

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sample immediately after the ablation, once stable sinus rhythm was achieved. Antiarrhythmic drugs were kept in patients with a history of atrial fibrillation (AF). β-blockers (BB) or other rate-control drugs were not discontinued when the rate in flutter was still rapid. Patients were routinely seen in the outpatient clinic within the first three months following the ablation and then at least once per year.

2.1. Variables

The following variables were collected in each center:

Demographic characteristics: age, sex, body mass index, presence of cardiovascular risk factors (diabetes, hypertension, dyslipidemia, cigarette consumption), physical examination, heart rate (HR) at the time of the ablation, QRS duration and presence of intraventricular conduction disease, ischemic heart disease, revascularization, non-ischemic heart disease (type of myocardiopathy), left ventricular ejection fraction (LVEF) at implant, NYHA class, rate-control drugs (including beta-blockers, sotalol, digoxin, calcium channel blockers) and medical treatment (angiotensin-receptor blocker, angiotensin-converting enzyme inhibitor, spironolactone, diuretic, oral anticoagulation and antiplatelet agents). Previous history of AF (paroxysmal or non-paroxysmal). Blood pressure at admission pre-implantation. Renal function, hemoglobin. Chronic obstructive pulmonary disease (COPD).

Finally, the AFL cycle length was measured at the duodecapolar catheter placed in the right atrium. The ventricular cycle length during AFL was measured on the surface ECG before the puncture in order to avoid being affected by any possible changes in the autonomic tone resulting from a venopuncture or sedative drugs.

Follow-up: number of hospital admissions, death from any cause or heart failure leading to hospitalization, stroke, all adverse events occurring within the first 30 days after CTI ablation, need of PMI during the follow-up and reason of the implantation.

2.2. Statistic analysis

The statistical analyses were performed with SPSS 21.0. The categorical or dichotomous variables were expressed as absolute values and percentages, and were compared with the Pearson χ^2 test. The continuous variables were described as the mean ± standard deviation (SD). Student *t* test was used for the comparisons of continuous variables between groups.

We examined the predictive value of heart rate using receiver operating characteristic (ROC) curve analysis. The incidence of pacemaker implantation was compared basing based on the cut off level previously obtained with ROC curve using the Kaplan–Meier analysis (with the log-rank p value).

The independent predictors of pacemaker implantation were tested by using logistic regression model (backward stepwise Cox proportional hazard analysis), after adjusting by those variables associated with pacemaker need ($p < 0.10$) in the univariate analysis. Results from the regression analyses were expressed as adjusted odds ratios (OR), and 95% confidence intervals (CI) were presented.

A p-value <0.05 was considered statistically significant.

3. Results

A total of 298 patients were considered eligible for inclusion. The mean age of the enrolled patients was 65.7 ± 11 years, 12.1% of which were women. The patient baseline characteristics are summarized in Table 1.

Table 1
Baseline characteristics of the study population.

	Patients (n = 298)
Age (years, SD)	65.8 (11)
LVEF (%, SD)	53.55 (13.5)
Male/female (n)	262/36
Creatinine mg/dl (SD)	1.09 (0.35)
BMI (SD)	29.8 (6.1)
Hypertension (n,%)	107 (57)
Diabetes mellitus (n,%)	68 (22.8)
COPD (n,%)	66 (22.1)
Dislipemia (n,%)	107 (35.9)
Left atrial diameter (mm) (SD)	44.9 (7.5)
CHADVASc (SD)	2.21 (1.4)
Cycle Length (ms, SD)	247 (35)
PAD (n,%)	18 (6)
CKD (n,%)	46 (15.4)
Heart rate before ablation (n,%)	88.1 (30.2)
Rate-control drugs[a] (n,%)	123 (56.2)

Abbreviations: AF: atrial fibrillation; BMI: body mass index. CKD: chronic kidney disease (MDRD-4 < 60 ml/min/1.73 m^2). LVEF: left ventricular ejection fraction. SD: standard deviation.

[a] Rate control drugs (beta-blockers, digoxin, calcium channel blockers).

During 57.7 ± 42.8 months of follow-up, 30 patients (10.1%) underwent PMI after successful CTI ablation. Reasons for the PMI were sinus node dysfunction (SND) (11 patients), auriculoventricular (AV) conduction disease (15 patients) and slow conducting AF (4 patients).

Patients requiring a PMI were more likely to be older (73.4 ± 8.8 vs 64.9 ± 10.8; $p > 0.001$), with higher baseline creatinine (1.3 ± 0.7 vs 1.06 ± 0.25; $p = 0.02$), lower heart rate at the time of the ablation (63.7 ± 28.9 vs 90.8 ± 29.1; $p < 0.001$) and with a trend to have longer tachycardia cycle length (258.61 ± 40 ms vs 245.92 ± 34 ms; $p = 0.09$) (Table 2). There was a difference in the antiarrhythmic agents or rate-control drugs (33.3% vs 59.4%; $p = 0.01$).

In the univariate logistic regression analysis age, heart rate at the time of the ablation, rate-control drugs, antiarrhythmic agents and ECG intraventricular conduction disturbance emerged as predictors of PMI requirement. In the stepwise multivariate models HR at the time of the ablation (OR: 0.96; 95% CI: 0.93–0.98; $p < 0.0001$) and ECG intraventricular conduction disturbance (OR: 3.87; 95% CI: 1.54–9.70; $p = 0.004$) were independent predictors of PMI need in the follow-up (Table 3).

The ROC curve analyses showed that the HR significantly discriminated between patients with and without the need of PMI in the follow-up, with area under the curve of 0.81 ($p < 0.001$) (Fig. 1). A HR of 65 bpm was identified as the optimal cut-off value to predict the need of PMI in the follow-up (sensitivity: 79% and specificity: 74%) (Fig. 2). Moreover, risk of PMI was more accentuated within the first 12 months after the ablation, afterwards it remained moderately stable (Fig. 3).

4. Discussion

In this non-trial-based cohort of patients with a history of CTI ablation for common AFL, ECG intraventricular conduction disturbance and slow ventricular response at the time of the ablation were strong predictors of the need of PMI in the long term. A HR of less than 65 bpm at the time of the ablation was identified as the optimal cut-off value to predict future need of PMI in the follow-up.

Table 2
Baseline characteristics of patients that required pacemaker implantation versus those who did not require pacemaker implantation.

	Pacemaker implantation (n = 31)	No pacemaker implantation (n = 267)	p
Age (SD)	73.4 (8.8)	64.9 (10.8)	<0.001
Female (n,%)	2 (6.5)	34 (12.7)	0.3
Creatinine (SD)	1.3 (0.7)	1.06 (0.25)	0.02
BMI (SD)	30.4 (3.7)	30.2 (5.1)	0.9
Hypertension (n,%)	20 (64.5)	150 (56.6)	0.4
Diabetes mellitus (n,%)	8 (25.8)	60 (22.5)	0.6
COPD (n,%)	4 (12.9)	62 (23.7)	0.1
LVEF (SD)	55.9 (11.1)	53.2 (13)	0.4
Left atrial diameter (mm) (SD)	41.4 (10)	45.3 (7)	0.13
Heart rate at the time of the ablation (bpm) (SD)	63.7 (28.9)	90.8 (29.1)	<0.001
Hypertension (n,%)	20 (64.5)	150 (56.6)	0.4
Dyslipidemia (n,%)	90 (32.3)	97 (36.9)	0.6
Coronary artery disease (n,%)	6 (19.4)	54 (20.5)	0.8
Dilated myocardiopathy (n,%)	3 (9.7)	26 (9.9)	0.9
Chronic kidney disease (n,%)	6 (19.4)	39 (15.1)	0.5
Rate-control drugs (n,%)	9 (33.3)	114 (59.4)	0.01
Periferic artery disease (n,%)	2 (6.9)	16 (6)	0.8
Atrial flutter cycle length (ms) (SD)	258.61 (40)	245.92 (34)	0.09
ECG intraventricular conduction disturbance (n,%)	17 (54.8)	60 (22.5)	<0.001

Abbreviations: AF: atrial fibrillation; BMI: body mass index; COPD: chronic obstructive pulmonary disease; LVEF: left ventricular ejection fraction. NS: non-significative.