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Conduction recovery following catheter ablation in patients with recurrent atrial fibrillation and heart failure

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ABSTRACT

Background: Atrial fibrillation (AF) catheter ablation is increasingly proposed for patients suffering from AF and concomitant heart failure (HF). However, the optimal ablation strategy remains controversial. We performed this study to assess the prevalence of pulmonary vein (PV) or linear lesion reconnection in HF patients undergoing repeated procedures.

Methods and results: At seven high-volume centres, 165 patients with HF underwent a repeat procedure after a first AF ablation including PV isolation alone (47 patients, group A) or PV isolation plus left atrial lines (118 patients, group B). Group A patients presented more often paroxysmal AF ($p < 0.001$), less enlarged left atrium ($p < 0.001$) and less left ventricular systolic dysfunction ($p = 0.031$) compared to Group B, that more commonly had atypical atrial flutter ($p < 0.001$). Forty-one (87%) patients in Group A and 69 (58%) in Group B presented at least one reconnected PV ($p < 0.001$). Sixty-one (52%) patients in Group B presented at least one reconnected atrial line (left isthmus or roof). Patients without any reconnected PV ($n = 54$, 33%) more frequently experienced persistent AF ($p < 0.001$), had longer AF duration ($p = 0.047$) and larger left atrial volume ($p < 0.001$). Twenty-five patients (15%) with no PV and/or line reconnection did not significantly differ, concerning baseline characteristics, compared to those with at least one reconnected ablation site.

Conclusion: As in the general AF population undergoing catheter ablation, PV reconnection is frequent in patients with HF and symptomatic recurrence. However, one third of patients presented arrhythmic recurrences even in the absence of PV reconnection, highlighting the importance of the underlying atrial substrate.

1. Introduction

Atrial fibrillation (AF) catheter ablation is a proven safe and effective therapeutic option for patients suffering from AF and concomitant heart failure (HF) [1–2]. Recent randomized trials [3–5] and a large meta-analysis [6] consistently reported an improvement in systolic HF symptoms and left ventricular ejection function (LVEF) after AF ablation. However, freedom from AF after a single procedure is limited, and when long-term outcomes of 5 years or greater are examined, recurrences occur in the majority of patients [7]. As a consequent, many patients with systolic HF (about one third) require at least two procedures to effectively maintain long-term sinus rhythm (SR) [7].

The optimal first line non pharmacological strategy to address AF in these patients remains controversial: previous studies supported, due to the complexity of the atrial substrate, left atrial linear ablation on top of pulmonary vein isolation (PVI) [8–10]. However, recent studies of AF ablation in general and surgical populations have failed to support the additive benefit of ablation beyond PVI [11–12]. In fact, aiming to investigate the singular role of PVI in AF ablation, a recent study reported, among a general population of patients undergoing repeated procedures for AF recurrence, a high prevalence of PV conduction recovery following the index PVI [13]. In this study, PV re-isolation alone was effective in subsequent SR maintenance, indirectly suggesting a durable role of PV triggers.

AF ablation patients that have concurrent systolic HF may have arrhythmia driven not only by PV triggers, but pathological atrial substrate; the latter reflecting chronic exposure of the atrium to the underlying diastolic and systolic dysfunction [14–15]. Nonetheless, there

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are no data available concerning sites of recovery or reconduction following a first transcatheter ablation procedure. We therefore conducted the present study aiming to determine the incidence of PV reconnection or failure of other linear lesions in in a population of patients with HF undergoing repeated procedures for recurrent atrial arrhythmia following a first, failed, AF ablation procedure.

2. Methods

The present multicentre study involved seven high-volume electrophysiological laboratories routinely performing AF transcatheter ablation in patients with a LVEF lower than 50%. All included patients had a history of drug-refractory, symptomatic, paroxysmal or persistent AF and a concomitant structural cardiomyopathy characterized by a LVEF <50%, received a prior AF ablation procedure at the same Center (including PV isolation and when appropriate additional left or right atrial lesions), and were referred for at least one additional AF catheter ablation procedure, due to the occurrence of documented AF, atypical atrial flutter or atrial tachycardia symptomatic recurrences. Arrhythmic recurrences were defined as any episode of AF, atypical atrial flutter or atrial tachycardia lasting at least 2 min and documented through 12-leads ECG, Holter monitoring or implantable loop recorder. Referral for redo ablation was considered in patients experiencing arrhythmia-related symptoms, left ventricular function and/or functional class impairment related to the arrhythmic recurrences. Patients in whom procedural details concerning the index or the repeated procedure (e.g. PVI, linear lines, etc.) were not complete or validated were excluded. All patients provided written informed consent to the catheter ablation procedures.

2.1. Recovery or reconduction assessment

The number and sites of PV conduction recovery were recorded. Additionally, in case left atrial (LA) linear lesions (roof line, mitral isthmus line, posterior line) had been performed at the first procedure, the persistence of block lines tested by pacing manoeuvres, activation and voltage mapping were registered.

The repeated procedures were then performed, according to each Center's preference or protocols, using 4-mm tip irrigated radiofrequency catheters or cryoballoon. Based on single patients' characteristics and atrial substrate, additional lesions such as PV isolation, LA linear lines, or complex fractionated atrial electrograms (CFAE) were performed [16].

2.2. Statistical analysis

Continuous variables were reported as mean (standard deviation, SD) or median (range), and categorical variables as number (%). Continuous data were compared by one-way ANOVA test after normal distribution was confirmed, and, in a selection of cases, additionally analysed as tertiles. Categorical variables were compared in cross-tabulation tables by Pearson's chi-square test. Due to the potential bias resulting from the inclusion of atypical flutter/tachycardia recurrences, that may rely on different pathophysiological mechanisms than those driving AF, data was also analysed considering only AF recurrences. Aiming to test the independent correlation of the recorded parameters, variables reporting a significant correlation at univariate analysis (p value < 0.05) were included in a multiple logistic regression analyses. The best subset models were run applying odds ratio (OR) likelihood scores. All tests of significance were two-tailed, and a p value < 0.05 was considered statistical significant. All analyses were performed using SPSS 21.0.

3. Results

At seven high-volume centres, out of 719 patients, over a mean period of 3 years (2012–2015), the 165 AF patients with concomitant HF undergoing a repeated transcatheter AF ablation were included (age 55 ± 17 years; 83% males). Baseline characteristics are listed in Table 1. Sixty-four (39%) patients suffered from paroxysmal AF, with a mean AF history duration of 74 ± 84 months. Echocardiographic parameters included a mean LA volume of 121 ± 68 ml, and a mean LVEF 41 ± 8%. At the time of the index procedure, 47 (28%, Group A) patients underwent PVI alone, while 118 (72%, Group B) underwent additional LA linear lesions or CFAE ablation; in particular, in 104 patients a roof line and mitral isthmus line were performed, and 44 underwent CFAE ablation. Patients in Group A presented higher prevalence of paroxysmal AF (p < 0.001), less severely enlarged LA volume (p < 0.001), less LVEF dysfunction (p = 0.031), shorter time to AF recurrence (p < 0.001), and a higher prevalence of prior antiarrhythmic Ic class drugs treatment (p = 0.019). In comparison, patients in Group B reported a higher prevalence of atypical atrial flutter recurrences, compared to Group A (p < 0.001).

Table 1
Baseline characteristics of the study population according to index procedure.

	Overall (n = 165)	Group A: PVI alone (n = 47)	Group B: PVI + lines (n = 118)	p-value
Age, years (SD)	55 (17)	53 (22)	56 (15)	0.401
Male sex, n (%)	137 (83%)	38 (81%)	99 (84%)	0.137
Paroxysmal AF, n (%)	64 (39%)	33 (70%)	32 (27%)	<0.001
Persistent AF, n (%)	43 (26%)	9 (19%)	33 (28%)	
Long-standing persistent AF, n (%)	59 (36%)	5 (10%)	53 (45%)	
AF duration, months (SD)	74 (84)	69 (68)	76 (91)	0.679
Hypertension, n (%)	106 (64%)	33 (70%)	72 (61%)	0.343
Diabetes mellitus, n (%)	26 (16%)	8 (18%)	16 (14%)	0.730
Previous stroke/TIA, n (%)	18 (11%)	5 (11%)	13 (11%)	0.782
CAD, n (%)	20 (12%)	6 (13%)	14 (12%)	0.989
Hyperthyroidism, n (%)	12 (7%)	2 (4%)	11 (9%)	0.093
Amiodarone use, n (%)	56 (34%)	14 (30%)	41 (35%)	0.499
Ic class drug use, n (%)	35 (21%)	16 (34%)	20 (17%)	0.019
Beta-blockers, n (%)	104 (63%)	33 (70%)	72 (61%)	0.296
OAC, n (%)	145 (88%)	38 (81%)	106 (90%)	<0.001
LVEF, % (SD)	41 (8)	44 (7)	41 (8)	0.031
LA volume, ml (SD)	121 (68)	56 (28)	152 (57)	<0.001
PVI alone, n (%)	47 (28%)	47 (100%)	0	–
PVI + lines, n (%)	118 (72%)	0	118 (100%)	–
Left isthmus line, n (%)	104 (62%)	0	104 (88%)	–
Roof line, n (%)	104 (62%)	0	104 (88%)	–
Posterior line, n (%)	21 (13%)	0	21 (18%)	–
CFAE, n (%)	44 (26%)	0	44 (42%)	–
Right isthmus ablation, n (%)	97 (58)	9 (19%)	88 (76%)	<0.001
Complications, n (%)	3 (2%)	1 (2%)	2 (3%)	0.541
Time to recurrence, months (SD)	12 (14)	8 (14)	9 (8)	<0.001
Paroxysmal AF recurrence, n (%)	44 (27%)	30 (63%)	14 (12%)	<0.001
Persistent AF recurrence, n (%)	56 (34%)	14 (30%)	42 (36%)	
Atypical flutter recurrence, n (%)	65 (39%)	3 (7%)	62 (52%)	
Number of reconnected PVs, n (SD)	1.9 (1.6)	3.1 (1.2)	1.5 (1.5)	<0.001
Reconnected PVs				<0.001
– 0	54 (32)	4 (8)	49 (42)	
– 1	16 (9)	1 (2)	15 (13)	
– 2	30 (18)	6 (13)	19 (16)	
– 3	24 (14)	11 (23)	13 (11)	
– 4	46 (27)	25 (54)	21 (18)	
Repeated procedure characteristics				
PVI alone, n (%)	61 (37%)	31 (65%)	43 (36%)	<0.001
PVI + lines, n (%)	61 (37%)	14 (30%)	27 (23%)	
Lines/CAFE alone, n (%)	43 (26%)	2 (5%)	48 (41%)	
Left isthmus line, n (%)	74 (44%)	7 (15%)	67 (56%)	<0.001
De novo left isthmus line, n (%)	7 (4%)	7 (15%)	–	–
Roof line, n (%)	70 (42%)	14 (30%)	56 (47%)	0.042
De novo roof line, n (%)	14 (8%)	14 (30%)	–	–
Posterior line, n (%)	23 (14%)	2 (4%)	21 (18%)	0.042
CFAE ablation, n (%)	33 (20%)	7 (15%)	26 (22%)	0.333
Right isthmus ablation, n (%)	42 (25%)	4 (9%)	38 (32%)	0.002
Complications, n (%)	5 (3.0%)	1 (2.1%)	4 (3.4%)	0.391

PVI: pulmonary vein isolation; AF: atrial fibrillation; TIA: transient ischaemic attack; CAD: coronary artery disease; OAC: oral anticoagulant; LVEF: left ventricular ejection fraction; LA: left atrium. CFAE: complex fractioned atrial electrograms.

Details concerning the second procedures are reported in Table 1. Briefly, 61 (37%) patients underwent repeated PVI alone, 61 (37%) underwent PVI and additional LA lesions while 43 (26%) underwent linear lesions or CFAE ablation; complication rate was 3.0%, without difference between Groups A and B (p = 0.391). Forty-one (87%) patients in Group A and 69 (58%) in Group B presented at least one reconnected PV (p < 0.001); no significant differences were detected among the prevalence of each of the four PV's recurrence rate (Figs. 1 and 2). Among patients in Group B, 61 (52%) and 55 (47%) presented, respectively, left isthmus and roof line reconnection across the line, and these patients underwent repeated linear ablation to achieve conduction block.

Among the two groups, 54 (33%) patients presented without evidence of reconnected PVs (Table 2); these patients were more often affected by persistent AF (p < 0.001), had a longer AF duration (p = 0.047), presented with more severely enlarged LA volumes

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