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ORIGINAL RESEARCH

Impact of Early Atrial Tachyarrhythmia Within the Blanking Period on Late Recurrence After Pulsed Field Ablation of Atrial Fibrillation

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ABSTRACT

BACKGROUND Early atrial tachyarrhythmias (ERAT) occurring during the first 3 months after atrial fibrillation (AF) ablation were not traditionally considered a treatment failure, and this defined the blanking period after thermal energy ablations. More recent data suggest that the blanking period after pulsed field ablation (PFA) is shorter. We hypothesized that the traditional concept of "blanking period" does not apply to PFA for AF.

OBJECTIVES This study sought to evaluate whether ERAT during the 3 months after PFA for AF predicts late recurrence and whether or not the timing of ERAT affects late recurrences.

METHODS All consecutive patients undergoing PFA for AF at our institution (Feb 2024- March 2025) were enrolled in a prospective registry and followed to assess arrhythmia recurrences. ERAT was defined as atrial fibrillation or flutter lasting ≥30 seconds within 90 days. Late arrhythmia recurrences (LRAT) were defined as recurrences after 90 days.

RESULTS Among 1,608 patients followed for 1 year, 334 (20.8%) experienced ERAT and were more likely to experience LRAT than those patients without ERAT (68.4% vs 20.3%, $P < 0.001$). In multivariable Cox analyses, ERAT was independently associated with LRAT (HR: 4.89; 95% CI: 4.04-5.93; $P < 0.001$). The risk of LRAT was consistently elevated using 30-day and 60-day ERAT timing cutoffs: ERAT ≤30 vs 31-90 days (LRAT = 70.4% vs 65.5%; $P = 0.41$; adjusted HR: 5.40 vs 4.34 respectively compared with no ERAT) and ERAT ≤60 vs 61-90 days (LRAT = 68.6% vs 67.1%; $P = 0.88$; adjusted HR: 4.91 vs 4.83 respectively) compared with no ERAT. In secondary analyses, LRAT rates were similar in ERAT patients with or without cardioversion (73% vs 66.7%, $P = 0.29$). Interaction testing showed no significant differences in these HRs across ERAT-timing or cardioversion subgroups (all $P > 0.05$). Moreover, ERAT was associated with a higher need for cardioversion (25.1% vs 7.2%, $P < 0.001$; HR: 1.49; 95% CI: 1.10-2.02; $P = 0.008$) and late arrhythmia recurrences compared with patients without ERAT.

CONCLUSIONS After PFA for AF, atrial tachyarrhythmias at any time within the first 3 months, regardless of timing or need for cardioversion, strongly predict late recurrence and warrant increased monitoring intensity in the early postablation period. (JACC Clin Electrophysiol. 2026;■:■-■) Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

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ABBREVIATIONS AND ACRONYMS

AF = atrial fibrillation

AFL = atrial flutter

DCCV = direct current cardioversion

ERAT = early recurrence of atrial tachyarrhythmia

ICE = intracardiac echography

LRAT = late recurrence of atrial tachyarrhythmia

PFA = pulsed field ablation

PVI = pulmonary vein isolation

Early atrial tachyarrhythmias (ERAT) occurring during the first 3 months after atrial fibrillation (AF) ablation were not traditionally considered a treatment failure, and this defined the blanking period after thermal energy ablations.[1] The concept of the blanking period was established in the 2007 expert consensus document based on observations that transient inflammation and reversible conduction abnormalities contribute to ERAT but without implications for long-term recurrences.[1,2]

Despite widespread adoption, the clinical relevance and optimal duration of the blanking period remain debated.[2] Studies using thermal ablation have reported conflicting associations between ERAT during the blanking period and late recurrence of atrial tachyarrhythmias (LRAT).[1,3] Although some data suggest ERAT is associated with increased risk of LRAT, other studies dispute this and support maintaining a blanking period.[4] Efforts to refine its duration have yielded mixed conclusions, including a 2022 meta-analysis suggesting a 4-week interval after catheter ablation and a 2024 international consensus update reducing the blanking period to 8 weeks.[5,6] These uncertainties have been amplified by the emergence of pulsed field ablation (PFA), a mechanistically distinct modality that produces myocardial injury through nonthermal electroporation with limited inflammatory response.[7,8] Given these differences, assumptions underlying the traditional blanking period may not directly apply to PFA.[9] Notably, even with the shortened 8-week blanking period after PFA, patients with ERAT have significantly lower freedom from atrial arrhythmia at 1 year than those without early recurrence, and emerging data suggest that this should be further shortened to a 4-week cutoff.[10]

Accordingly, the present study evaluated the prognostic implications of atrial arrhythmias occurring during the first 3 months following PFA. We also assessed the prognostic implications of timing of ERAT, stratified by 30-day and 60-day cutoffs as well as by individual months, and the risk of late atrial arrhythmia recurrence and the prognostic implications of ERAT persistence requiring direct current cardioversion (DCCV).

METHODS

STUDY GROUP AND DESIGN. All consecutive patients undergoing PFA for persistent or paroxysmal AF between February 2024 and March 2025 at Cleveland Clinic in Cleveland, Ohio, were enrolled in a prospectively maintained AF ablation registry. PFA catheters approved by the US Food and Drug Administration were used. ERAT was defined as the occurrence of AF or atrial flutter (AFL) lasting ≥30 seconds recorded within the first 90 days of ablation. LRAT was defined as any recurrence of AF or AFL lasting more than 30 seconds and recorded beyond 90 days from the ablation procedure. Continuous oral anticoagulation therapy was maintained for at least 3 weeks before the procedure and continued perioperatively without interruption. A total of 1,608 consecutive patients met the inclusion criteria. The study was approved by the Cleveland Clinic Institutional Review Board.

ABLATION PROCEDURES. Generally, all antiarrhythmic medications were stopped 4-5 half-lives before ablation. All ablation procedures were performed without interruption of therapeutic anticoagulation. All patients underwent AF ablation using PFA under general anesthesia. Under ultrasound guidance, intravascular sheaths were placed in each of the right and left femoral veins. An intracardiac echocardiography (ICE) catheter was placed in the right atrium via the left femoral vein in all procedures. A steerable decapolar catheter was placed in the coronary sinus for recording and pacing, as needed. Intracardiac echocardiography imaging for transseptal guidance, catheter positioning, catheter-tissue contact, and to monitor for complications was performed primarily from the right atrium. The ICE catheter was advanced into the left atrium only when necessary to optimize visualization of left atrial ablation. Real-time and continuous use of intracardiac echocardiography with each application was performed and achieved by optimizing imaging angles and catheter positioning. Heparin was administered to

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The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the Author Center.

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maintain an activated clotting time ≥300 seconds, with levels monitored every 10 to 15 minutes throughout the procedure. A single transseptal approach was performed using standard techniques. Left atrial electroanatomic maps were created using high-density mapping catheters and commercially available mapping systems, at operators' discretion. The vast majority of patients in this study (>95%) underwent ablation using the Farapulse pentaspline PFA catheter (Boston Scientific). A small proportion of cases were performed using alternative PFA platforms including the Sphere-9 catheter or Affera mapping and ablation system (Medtronic). Pulmonary vein isolation (PVI) was achieved with overlapping applications in both flower and basket configurations. Lesion delivery and catheter positioning were guided by fluoroscopy, electroanatomic mapping, and intracardiac echocardiography. Overlapping PFA applications were routinely performed to ensure continuity of ablation sets. Cavotricuspid isthmus ablation was performed using the pentaspline catheter, with confirmation of bidirectional block in patients with documented typical AFL. Additional ablations for concomitant arrhythmias were performed as clinically indicated, and no empirical linear lesions were created. Posterior wall ablation was performed in all patients using overlapping PFA applications to cover the entire posterior left atrial wall between the pulmonary veins, representing comprehensive posterior wall ablation rather than formal box isolation. In patients who remained in AF after PVI, electrical cardioversion to sinus rhythm was performed and followed by confirmation of PVI in sinus rhythm.

CLINICAL AND FOLLOW-UP DATA. Clinical and follow-up data were collected before the procedure on the day of ablation and at subsequent follow-up scheduled visits with 12-lead electrocardiography at 3, 6, and 12 months and on a yearly basis thereafter, and were continuously updated in electronic medical records. More frequent follow-up visits were scheduled as needed for patients with arrhythmia recurrence and for those who had symptoms or required close management of their long-term anticoagulation.

Continuous 2-week monitoring was used within the first 2 weeks postablation, at 3-months and 6-months postablation, and every 6 months thereafter. Interrogation of implanted devices, whenever available, was also used to assess for recurrences. Additional monitoring was obtained beyond the 3-month period for patients with documented arrhythmia and for those who developed symptoms consistent with arrhythmia during the 3-month period. Atrial arrhythmias that occurred during the first 3 months after ablation were categorized as early recurrences for the purpose of this study. Antiarrhythmic medication use during the initial 3 months was at operators' discretion. Patients receiving antiarrhythmic drugs at baseline generally continued these medications through the blanking period, with discontinuation considered at approximately 2 months postablation unless ongoing arrhythmia warranted continued therapy. Initiation of new antiarrhythmic drugs after ablation was generally reserved for patients with documented symptomatic recurrences.

All clinical documentation, including telephone encounters and other forms of communication with patients or their referring physicians, was documented electronically. Electronic records were maintained and regularly updated with clinical data collected before ablation, ablation procedure data, and data from subsequent follow-up visits in addition to all unscheduled visits, telephone encounters, and communication with referring physicians.

OUTCOMES AND ARRHYTHMIA RECURRENCES. The primary outcome was 1-year freedom from LRAT, defined as any atrial arrhythmia (AF or AFL) occurring beyond 90 days after the ablation procedure. Arrhythmia recurrence was defined as electrocardiographic documentation of an atrial tachyarrhythmia lasting ≥30 seconds on a 12-lead electrocardiogram, event recorder, or Holter monitor, with or without symptoms. Patients without recurrence of atrial arrhythmia were censored at the date of last follow-up.

Patients were stratified into 2 primary groups based on whether or not they had ERAT. To evaluate the recently proposed shortened blanking periods, patients with ERAT were further stratified as follows: 1) ERAT ≤30 days vs ERAT 31-90 days, to assess whether or not a 1-month blanking period is appropriate; and 2) ERAT ≤60 days vs ERAT 61-90 days, to assess whether or not a 2-month blanking period is appropriate. In secondary analysis, patients with ERAT were also stratified by month of first recurrence (month 1, month 2, or month 3). Secondary analyses further evaluated ERAT requiring DCCV during the blanking period and DCCV requirement after 90 days of ablation.

STATISTICAL ANALYSES. Continuous variables were expressed as mean ± standard deviation and were compared between groups using the Student's *t*-test or the Mann-Whitney *U* test, as appropriate. Normal distribution of variables was assessed using the Shapiro-Wilk test. Categorical variables were presented as frequencies and percentages and were

TABLE 1 Baseline Characteristics of All Patients

Characteristic	Overall (N = 1,608)	Not ERAT (n = 1,274)	ERAT (n = 334)	*P* Value
Age, y	67.9 ± 10.2	67.6 ± 10.2	68.8 ± 10.0	0.110
Male	1,091 (67.8)	879 (69.0)	212 (63.5)	0.063
Redo procedure	389 (24.2)	274 (21.5)	115 (34.4)	<0.001
Persistent AF	1,263 (78.5)	989 (77.6)	274 (82.0)	0.095
Atrial flutter	345 (21.5)	262 (20.6)	83 (24.9)	0.105
Antiarrhythmic drug	438 (27.2)	344 (27.0)	94 (28.1)	0.728
Anticoagulation	1,589 (98.8)	1,258 (98.7)	331 (99.1)	0.799
BMI, kg/m^2	30.1 ± 6.0	29.9 ± 5.9	30.6 ± 6.4	0.123
Coronary artery disease	114 (7.1)	94 (7.4)	20 (6.0)	0.446
Diabetes mellitus	243 (15.1)	191 (15.0)	52 (15.6)	0.860
Hypertension	956 (59.5)	755 (59.3)	201 (60.2)	0.809
Valvular heart disease	263 (16.4)	193 (15.1)	70 (21.0)	0.013
TIA/CVA	123 (7.6)	94 (7.4)	29 (8.7)	0.495
CHA_2DS_2-VASc score	2.5 ± 1.5	2.4 ± 1.5	2.7 ± 1.5	0.002
Ejection fraction, %	54.6 ± 10.2	54.8 ± 10.1	53.9 ± 10.7	0.148

Values are median ± SD or n (%).

AC = anticoagulation drugs; AAD = antiarrhythmic drugs; BMI = body mass index; CAD = coronary artery disease; DM = diabetes mellitus; EF = ejection fraction; HTN = hypertension; TIA/CVA = transient ischemic attack/cerebral vascular incident.

compared using the chi-square test or Fisher's exact test, as indicated. Time-to-event outcomes were assessed using Kaplan-Meier survival analysis, with comparisons performed using the log-rank test. Cox proportional hazards regression was used to assess factors associated with late recurrence of arrhythmia. Factors which were assessed in univariable analyses included age, sex, body mass index, AF type (persistent vs paroxysmal), AFL at baseline, de novo vs redo ablation, diabetes mellitus, hypertension, prior cerebrovascular events, coronary artery disease, valvular heart disease, ejection fraction, CHA_2DS_2-VASc score, antiarrhythmic drug use, and anticoagulants, in addition to the primary variable of interest (ERAT). Multivariable Cox proportional hazards models included all clinically relevant covariates (age, sex, body mass index, AF type, prior ablation, diabetes mellitus, hypertension, prior cerebrovascular event, coronary artery disease, valvular heart disease, ejection fraction, CHA_2DS_2-VASc score, baseline antiarrhythmic drug use, and anticoagulant use). HR with corresponding 95% CIs were reported. A 2-sided *P* value less than 0.05 was considered statistically significant. All statistical analyses were performed, and all figures were generated using R (version 4.4.3; R Foundation for Statistical Computing).

RESULTS

STUDY GROUP. Of 1,608 patients undergoing PFA for AF, 1,274 (79.2%) had no atrial arrhythmia during the first 3 months (no ERAT), whereas 334 (20.8%) experienced an arrhythmia (ERAT). Patients with ERAT had a higher history of valvular heart disease (21% vs 15%; $P = 0.013$), higher CHA_2DS_2-VASc score (2.7 ± 1.4 vs 2.4 ± 1.5; $P = 0.002$), and were more likely to have had a before ablation procedure (34.4% vs 21.5%; $P < 0.001$). The demographics of the study group categorized by ERAT status are summarized in Table 1.

PRIMARY OUTCOME: LATE ARRHYTHMIA RECURRENCE. Over a 1-year follow-up period, late arrhythmia recurrences beyond 90 days from ablation occurred in 228 of 334 patients with ERAT (68.4%) and in 259 of 1,274 patients without ERAT (20.3%; $P < 0.001$). In Kaplan-Meier analysis, arrhythmia-free survival was higher in patients without ERAT vs those with ERAT (log-rank $P < 0.001$) (Figure 1).

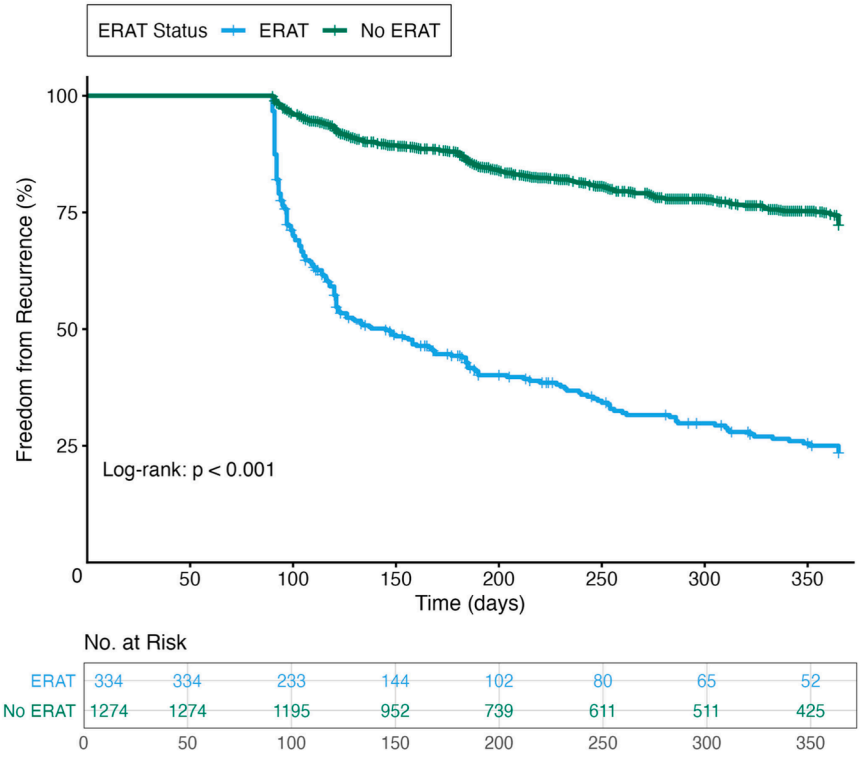
COX PROPORTIONAL HAZARDS ANALYSES. In univariable Cox regression, early recurrence of arrhythmia in the first 3 months of ablation was associated with a significantly greater risk of late recurrences compared with no ERAT (HR: 5.19; 95% CI: 4.33-6.20; $P < 0.001$). Other factors found to have a significant association with arrhythmia recurrence after 90 days were older age (HR: 1.01; 95% CI: 1.00-1.02; $P = 0.018$), higher body mass index (HR: 1.02; 95% CI: 1.00-1.03; $P = 0.02$), undergoing redo ablation at enrollment (HR vs no prior ablation:1.80; 95% CI: 1.49-2.18; $P < 0.001$), persistent AF (HR: 1.44; CI: 1.15-1.81; $P = 0.002$), history of valvular heart disease (HR: 1.34; CI: 1.08-1,67; $P = 0.009$), and increasing CHA_2DS_2-VASc score (HR: 1.11; CI: 1.05-1.17; $P < 0.001$). Man was associated with lower recurrence (HR: 0.83; 95% CI: 0.69-1.00; $P = 0.046$).

In multivariable regression models including all clinically relevant covariates, ERAT within 3 months remained significantly associated with late arrhythmia recurrence (HR: 4.89; 95% CI: 4.04-5.93; $P < 0.001$; Table 2).

ERAT STRATIFIED BY 30-DAY AND 60-DAY CUTOFFS. To evaluate whether shortening the blanking period alters the prognostic significance of early recurrence, patients with ERAT were stratified using 30-day and 60-day cutoffs.

30-day cutoff. Among 334 patients with ERAT, 189 (56.6%) experienced first recurrence within 30 days and 145 (43.4%) between days 31 and 90. Late recurrence occurred in 70.4% (133 of 189) of patients with ERAT ≤30 days compared with 65.5% (95 of 145) of patients with ERAT >30 days ($P = 0.41$). Kaplan-Meier analysis demonstrated comparable arrhythmia-free survival in patients with ERAT ≤30 days vs those

FIGURE 1 Freedom From Atrial Arrhythmia By ERAT Status



Kaplan-Meier curves showing 1-year freedom from atrial arrhythmia in patients with vs without early recurrence of atrial tachyarrhythmia (ERAT) during the 90-day blanking period after pulsed-field ablation for atrial fibrillation. Log-rank $P < 0.001$.

with ERAT >30 days, and both were lower than that of patients without ERAT (log-rank $P < 0.001$ vs no ERAT; Figure 2). In univariable Cox proportional hazards analyses, both groups demonstrated high hazards for late recurrence compared with no ERAT (HR: 5.80, 95% CI: 4.72-7.18 for ERAT ≤30 days; HR: 4.51, 95% CI: 3.56-5.71 for ERAT >30 days; $P < 0.001$ for both). In multivariable analyses, these associations remained significant (HR: 5.40, 95% CI: 4.31-6.75 for ERAT ≤30 days; HR: 4.34, 95% CI: 3.39-5.57 for ERAT >30 days; $P < 0.001$ for both; Table 3).

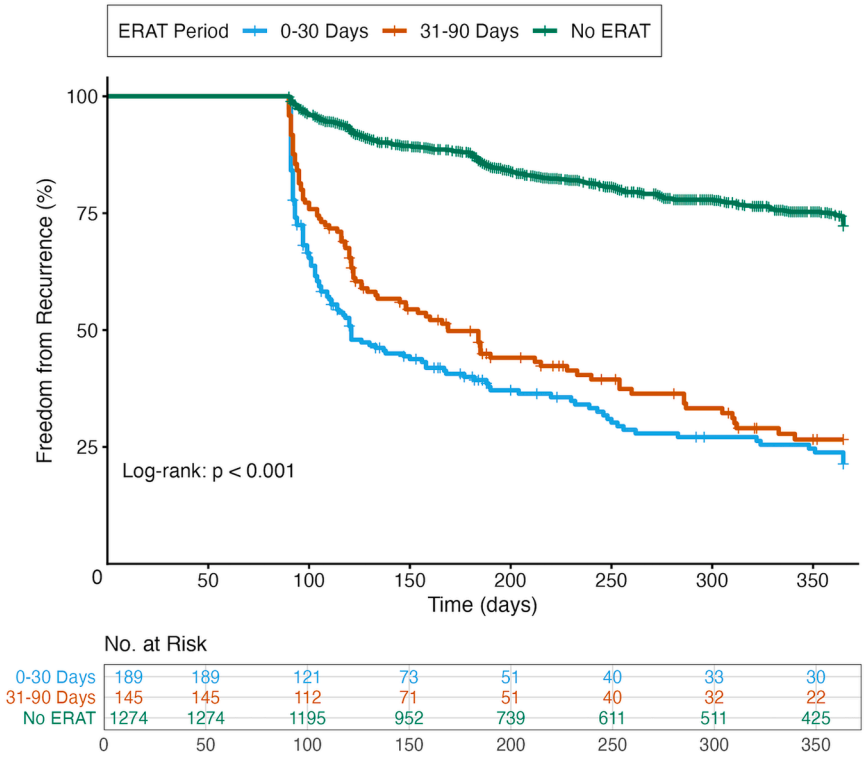
60-day cutoff. Among 334 patients with ERAT, 261 (78.1%) experienced first recurrence within 60 days and 73 (21.9%) between days 61 and 90. Late recurrence occurred in 68.6% (179 of 261) of patients with ERAT ≤60 days compared with 67.1% (49 of 73) of patients with ERAT >60 days ($P = 0.88$). Kaplan-Meier analysis demonstrated comparable arrhythmia-free survival in patients with ERAT ≤60 days vs those with ERAT >60 days, and both were lower than that of patients without ERAT

TABLE 2 Univariable and Multivariable Cox Regression for Late Arrhythmia Recurrence After 90 Days of Ablation

	Univariable			Multivariable		
Characteristic	HR	95% CI	*P* Value	HR	95% CI	*P* Value
Age, y	1.01	1.00, 1.02	0.018	1.00	0.99, 1.02	0.703
Male	0.83	0.69, 1.00	0.046	0.99	0.77, 1.27	0.932
BMI, kg/m^2	1.02	1.00, 1.03	0.020	1.01	0.99, 1.02	0.381
Redo procedure	1.80	1.49, 2.18	<0.001	1.57	1.28, 1.92	<0.001
Persistent AF	1.44	1.15, 1.81	0.002	1.15	0.90, 1.47	0.261
Diabetes mellitus	1.10	0.86, 1.40	0.433	0.89	0.66, 1.22	0.472
Hypertension	1.15	0.96, 1.39	0.126	1.02	0.79, 1.31	0.888
Coronary artery disease	0.96	0.67, 1.36	0.810	0.91	0.61, 1.35	0.643
Valvular heart disease	1.34	1.08, 1.67	0.009	1.04	0.82, 1.31	0.742
TIA/CVA	1.06	0.76, 1.47	0.724	0.92	0.57, 1.49	0.744
CHA_2DS_2-VASc score	1.11	1.05, 1.17	<0.001	1.06	0.93, 1.21	0.387
Ejection fraction, %	0.99	0.99, 1.00	0.163	1.00	0.99, 1.01	0.515
Antiarrhythmic drugs	0.92	0.75, 1.13	0.442	0.88	0.71, 1.09	0.257
Anticoagulation drugs	0.87	0.41, 1.83	0.712	0.65	0.29, 1.46	0.294
ERAT within first 3 mo	5.19	4.33, 6.20	<0.001	4.89	4.04, 5.93	<0.001

AF = atrial fibrillation; BMI = body mass index; CHA_2DS_2-VASc = congestive heart failure, hypertension, age ≥75, diabetes, stroke, vascular disease, aged 65-74, sex category score; ERAT = early recurrence of atrial tachyarrhythmia; TIA/CVA = transient ischemic attack/cerebral vascular incident.

FIGURE 2 Freedom From Atrial Arrhythmia by 30-Day ERAT Cutoff



Kaplan-Meier curves showing 1-year freedom from atrial arrhythmia in patients with ERAT occurring within 30 days, ERAT occurring after 30 days, and patients without ERAT during the 90-day blanking period after pulsed field ablation. Log-rank $P < 0.001$ vs no ERAT. Abbreviation as in Figure 1.

(log-rank $P < 0.001$ vs no ERAT; Figure 3). In univariable Cox proportional hazards analyses, both groups demonstrated high hazards for late recurrence compared with no ERAT (HR: 5.32, 95% CI: 4.39-6.45 for ERAT ≤60 days; HR: 4.76, 95% CI: 3.51-6.47 for ERAT >60 days; $P < 0.001$ for both). In multivariable analyses, these associations remained significant (HR: 4.91, 95% CI: 4.00-6.02 for ERAT ≤60 days; HR: 4.83, 95% CI: 3.49-6.68 for ERAT >60 days; $P < 0.001$ for both; Table 3). The multivariable-adjusted HRs for ERAT across both the 30-day and 60-day cutoff analyses are illustrated in Figure 4.

ERAT STRATIFIED BY MONTH. Among the 334 patients with ERAT, the first episode occurred in 189 patients (56.6%) during month 1, 72 patients (21.6%) during month 2, and 73 patients (21.9%) during month 3. Demographic and clinical characteristics stratified by month of first recurrence are presented in Table 4. Late recurrence occurred in 70.4% (133 of 189) of patients whose first arrhythmia occurred in month 1, 63.9% (46 of 72) in month 2, and 67.1% (49 of 73) in month 3, with no significant difference between groups ($P = 0.59$). Kaplan-Meier analysis demonstrated low rates of arrhythmia-free survival regardless of the timing of first ERAT event compared with patients without ERAT (log-rank $P < 0.001$ vs no ERAT; Figure 5).

In univariable Cox proportional hazards analyses, ERAT in month 1, month 2, and month 3 all demonstrated high hazards for late recurrence compared with no ERAT (HR: 5.83, 95% CI: 4.72-7.20 for month 1; HR: 4.40, 95% CI: 3.21-6.03 for month 2; HR: 4.91, 95% CI: 3.61-6.67 for month 3; $P < 0.001$ for all). In multivariable analyses, these associations remained significant (HR: 5.40, 95% CI: 4.31-6.76 for month 1; HR: 3.93, 95% CI: 2.84-5.45 for month 2; HR: 4.83, 95% CI: 3.49-6.69 for month 3; $P < 0.001$ for all; Table 5).

PERSISTENCE OF ERAT REQUIRING DCCV. Among the 334 patients with ERAT, 88 (26.3%) required DCCV within 90 days and 246 (73.7%) did not.

TABLE 3 Multivariable-Adjusted Hazard Ratios for Late Arrhythmia Recurrence By 30- and 60-Day ERAT Cutoffs, With No ERAT as Reference

	Univariable			Multivariable		
Patient Group	HR	95% CI	*P* Value	HR	95% CI	*P* Value
No arrhythmia during first 3 mo (1,274)		(Reference)				
≤30 d vs >30 d						
ERAT within first 30 d (189)	5.80	4.72-7.18	<0.001	5.40	4.31-6.75	<0.001
ERAT between 31 and 90 d (145)	4.51	3.56-5.71	<0.001	4.34	3.39-5.57	<0.001
≤60 d vs >60 d						
ERAT within first 60 d (261)	5.32	4.39-6.45	<0.001	4.91	4.00-6.02	<0.001
ERAT between 61 and 90 d (73)	4.76	3.51-6.47	<0.001	4.83	3.49-6.68	<0.001

ERAT = early recurrence of atrial tachyarrhythmia.

Kaplan-Meier analysis demonstrated lower rates of arrhythmia-free survival regardless of whether patients required cardioversion for ERAT, compared with those without ERAT (log-rank $P < 0.001$ vs no ERAT; **Figure 6**). In univariable analysis, ERAT persistence requiring DCCV and ERAT without DCCV were both associated with increased late recurrence compared with no ERAT (HR: 6.93, 95% CI: 2.85-16.8, and HR: 7.93, 95% CI: 4.21-14.91, respectively; $P < 0.001$ for both). These findings remained significant in multivariable analysis (HR: 4.17; 95% CI: 3.11-5.60, and HR: 5.24, 95% CI: 4.25-6.48, respectively; $P < 0.001$ for both; **Table 5**). Although the adjusted HR was numerically higher in patients with ERAT not requiring DCCV, late recurrence rates were not significantly different between ERAT patients with and without DCCV. The multivariable-adjusted HRs for late arrhythmia recurrence by month of ERAT occurrence and cardioversion status are illustrated in **Figure 7**.

To test whether the hazard of late recurrence differed depending on ERAT timing or cardioversion status, we directly compared HRs between ERAT subgroups using interaction testing, rather than comparing each subgroup separately with the no-ERAT reference group. No significant interaction was observed between ERAT ≤30 days and ERAT 31-90 days ($P = 0.122$), between ERAT ≤60 days and ERAT 61-90 days ($P = 0.921$), across month 1, month 2, and month 3 of first ERAT occurrence ($P = 0.190$), or between ERAT with and without cardioversion during the blanking period ($P = 0.147$).

SENSITIVITY ANALYSIS BY BASELINE ANTIARRHYTHMIC DRUG USE. Among 1,608 patients, 438 (27.2%) were receiving AADs at baseline, and 1,170 (72.8%) were not. Among patients receiving AADs at baseline, 94 developed ERAT and 344 did not; LRAT occurred in 67.0% (63 of 94) of patients with ERAT versus 16.9% (58 of 344) of those without ERAT (HR: 6.77; 95% CI: 4.72-9.72; $P < 0.001$). Among patients not receiving AADs at baseline, 240 developed ERAT and 930 did not; LRAT occurred in 68.8% (165 of 240) of patients with ERAT vs 21.6% (201 of 930) of those without ERAT (HR: 4.80; 95% CI: 3.90-5.90; $P < 0.001$). Kaplan-Meier analysis demonstrated consistently lower arrhythmia-free survival among patients with ERAT than among those without ERAT across both subgroups (Supplemental Figures A and B). No significant interaction was identified between ERAT status and baseline AAD use (interaction $P = 0.086$).

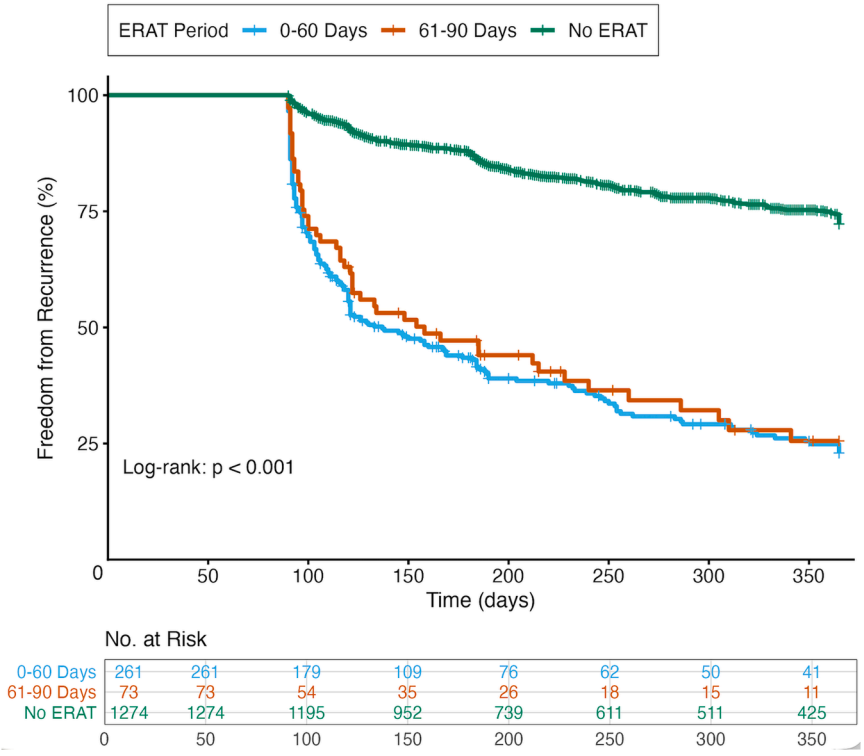
LATE ARRHYTHMIA RECURRENCES REQUIRING DCCV. Of the 334 patients with ERAT, 84 (25.1%) experienced LRAT that required cardioversion, vs 92 (7.2%) in patients without ERAT; $P < 0.001$. In multivariable Cox proportional hazards analysis using patients without ERAT as reference, ERAT was associated with a higher risk of DCCV beyond 90 days (HR: 1.49; 95% CI: 1.10-2.02; $P = 0.008$).

The **Central Illustration** summarizes the study population and the association of ERAT, its timing, and cardioversion status with late atrial tachyarrhythmia recurrence after PFA.

DISCUSSION

To our knowledge, this is the largest study to date evaluating the prognostic implications of early arrhythmia recurrence after PFA and its impact on late arrhythmia recurrence. In 1,608 patients who underwent PFA for AF and were followed prospectively, ERAT was associated with a high risk of late arrhythmia recurrence, which was significant in multivariable models accounting for potential confounding factors. Importantly, neither a 30-day nor a 60-day cutoff meaningfully discriminated late recurrence risk, suggesting that ERAT carries

FIGURE 3 Freedom From Arrhythmia by 60-Day ERAT Cutoff



Kaplan-Meier curves showing 1-year freedom from atrial arrhythmia in patients with ERAT occurring within 60 days, between 61 and 90 days, and patients without ERAT during the 90-day blanking period after pulsed field ablation. Log-rank $P < 0.001$ vs no ERAT. Abbreviation as in Figure 1.

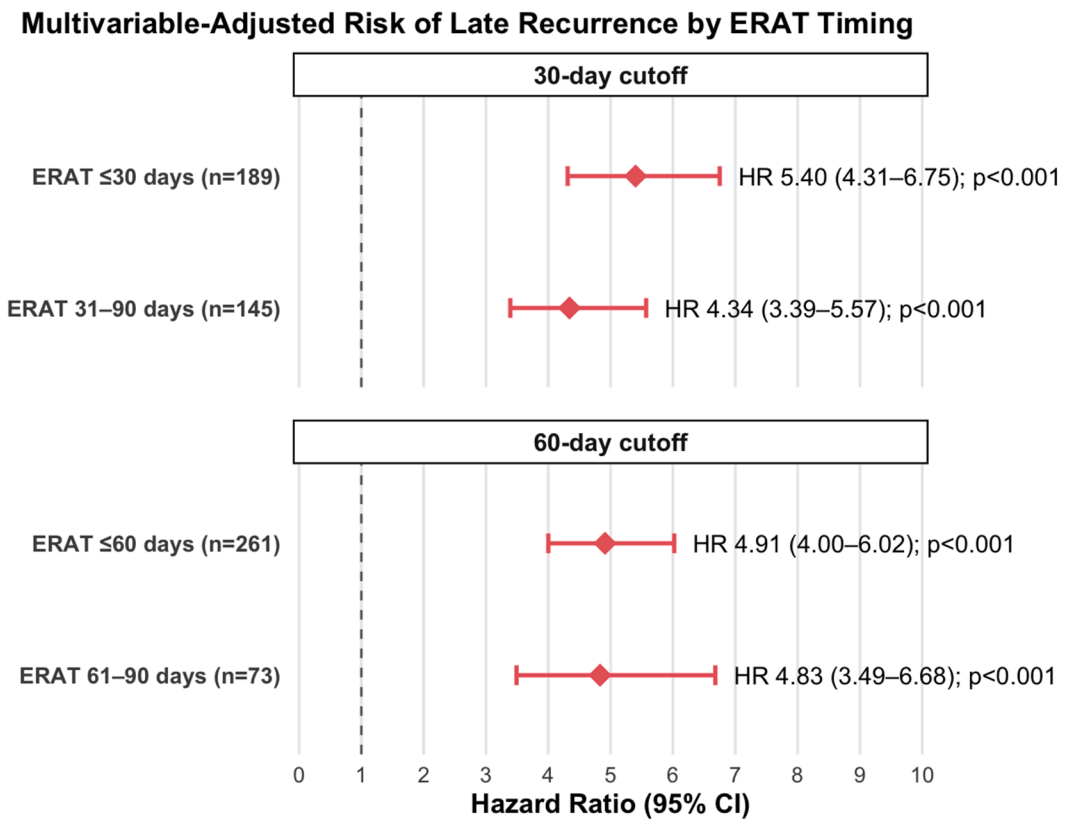
prognostic significance regardless of its timing within the first 90 days after PFA.

The findings add to the accumulating evidence about ERAT and late recurrences after PFA. In a secondary analysis of the PULSED AF trial, including 588 patients, ERAT occurred in 29.3% and was strongly predictive of LRAT (HR: 6.4 for paroxysmal AF; HR: 3.8 for persistent AF) over 12 months of follow-up.[11] Similarly, the admIRE study demonstrated that 71% of patients with ERAT after PFA developed LRAT (adjusted HR: 7.9).[12] A 2026 systematic review by Pamporis et al[13] found that ERAT within 0-90 days was predictive of arrhythmia recurrences with a positive predictive value of 0.66. Urbanek et al[14] reported a cohort of 1,000 patients in which ERAT occurred in 16.2% and was strongly associated with LRAT (1-year freedom 48% vs 81%), and importantly, when a shortened 8-week blanking period was applied, early recurrence remained prognostically significant. Similarly, Bisignani et al[15] reported that among 620 patients, ERAT occurred in only 7.1% yet remained independently associated with late recurrence (HR: 3.26), with left atrial volume index identified as the primary predictor rather than timing within the blanking period.

In contrast, Mohanty et al[16] reported that recurrence in months 2 or 3 was the only independent predictor of late recurrence (HR: 2.64, $P < 0.001$), whereas month-1 recurrence was not statistically significant, leading the investigators to propose shortening the blanking period to 1 month. Similarly, a 2026 meta-analysis by Arevalo et al[10] found that first-month ERAT was not predictive of LRAT (OR: 1.30; 95% CI: 0.55-3.09; $P = 0.52$), whereas ERAT in months 2 and 3 strongly predicted late recurrence.

Our findings reproduce prior observations of ERAT within 90 days and its association with long-term recurrences and show that any arrhythmia recurrence in the first 3 months, regardless of timing, is independently associated with recurrence. Although prior reports suggested that arrhythmias in the first month after PFA were not associated with recurrence, these studies may have been limited by

FIGURE 4 Late Recurrence Hazard Ratios by 30- and 60-Day ERAT Cutoffs



Forest plot showing multivariable-adjusted HRs for late arrhythmia recurrence among patients with ERAT occurring within vs beyond 30-day and 60-day cutoffs after pulsed field ablation, with no ERAT as the reference group. Error bars represent 95% CIs. Abbreviation as in Figure 1.

sample size and monitoring strategies. Our findings show that a 1-month cutoff for defining the blanking period is not appropriate, as ERAT predicts late recurrence with a similarly high risk regardless of whether it occurs in the first, second, or third month after PFA. The temporal prognostic implications of ERAT contrast sharply with data from thermal ablation. In the DECAAF-II (Delayed-Enhancement MRI Determinant of Successful Radiofrequency Catheter Ablation of Atrial Fibrillation II) study of radiofrequency ablation, there was evidence of temporal associations, such as third-month recurrences, which demonstrated the strongest association with late recurrence (HR: 10.15), followed by second-month (HR: 2.35) and first-month recurrences (HR: 1.5).[17] Similarly, in cryoballoon ablation registries, recurrences beyond 30 days were the strongest predictor of long-term recurrence, and Saglietto et al[5] identified an optimal blanking period of 27.7 days for thermal ablation.[18,19] The authors in the SINGLE SHOT CHAMPION (Comparison of Cryoballoon vs. Pulsed Field Ablation in Patients with Symptomatic Paroxysmal Atrial Fibrillation) trial comparing PFA to cryoballoon ablation noted that "the significantly lower recurrence rate during the blanking period with PFA suggests reduced inflammation," and they concluded that "this finding may challenge the use of blanking periods in future studies."[9] Our data provide additional evidence that the predictive significance of ERAT after PFA may differ from that observed in previous ablation modalities.

The observed differences between PFA and thermal ablation are likely explained by fundamental differences in lesion biology. Through nonthermal irreversible electroporation, PFA induces less inflammation than thermal technologies and causes myocardial necrosis through cell membrane destabilization while sparing the extracellular matrix.[7,20]

TABLE 4 Baseline Characteristics of Patients Stratified By Month of Early Recurrence of Arrhythmia

Characteristic	Month 1 (N = 189)	Month 2 (N = 72)	Month 3 (N = 73)	*P* Value[a]
Age, y	69.3 ± 10.4	68.2 ± 10.1	68.4 ± 8.9	0.419
Male	117 (61.9)	49 (68.1)	46 (63.0)	0.651
Redo procedure	68 (36.0)	26 (36.1)	21 (28.8)	0.515
Persistent AF	151 (79.9)	59 (81.9)	64 (87.7)	0.339
Atrial flutter	45 (23.8)	17 (23.6)	21 (28.8)	0.681
Antiarrhythmic drug	56 (29.6)	20 (27.8)	18 (24.7)	0.723
Anticoagulation	189 (100.0)	70 (97.2)	72 (98.6)	0.093
BMI, kg/m^2	30.5 ± 6.5	30.6 ± 6.5	30.9 ± 6.0	0.776
Coronary artery disease	9 (4.8)	2 (2.8)	9 (12.3)	0.030
Diabetes mellitus	30 (15.9)	12 (16.7)	10 (13.7)	0.872
Hypertension	119 (63.0)	45 (62.5)	37 (50.7)	0.172
Valvular heart disease	41 (21.7)	12 (16.7)	17 (23.3)	0.577
TIA/CVA	18 (9.5	5 (6.9)	6 (8.2)	0.793
CHA_2DS_2-VASc score	2.7 ± 1.4	2.6 ± 1.5	2.6 ± 1.7	0.844
Ejection fraction, %	53.8 ± 10.1	54.2 ± 12.2	53.8 ± 10.7	0.610

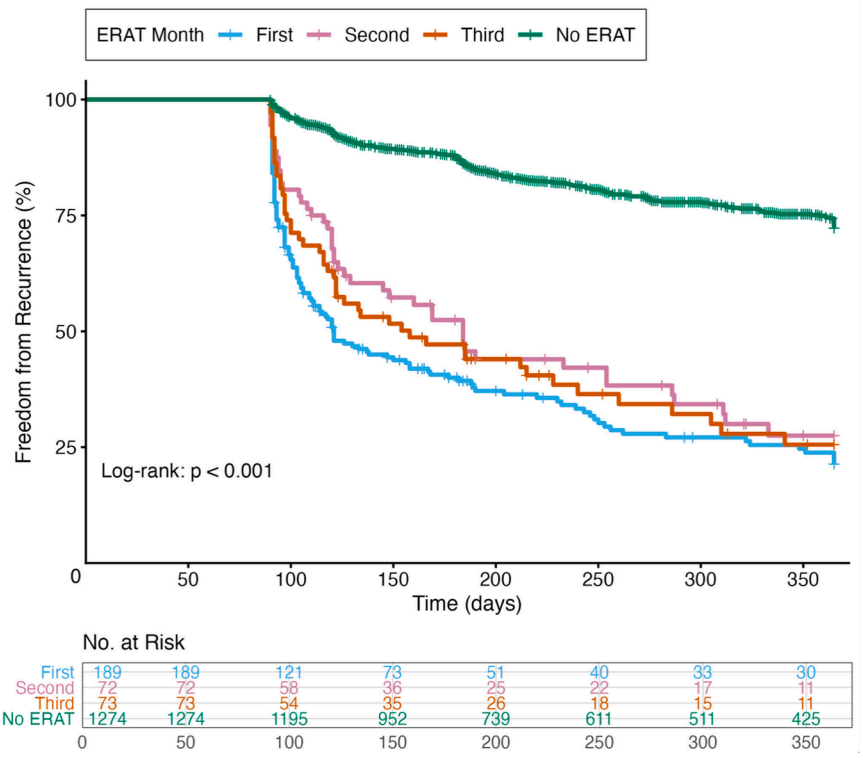
Values are mean ± SD or n (%). [a]Pearson's Chi-squared test; Kruskal-Wallis rank sum test.

AF = atrial fibrillation; BMI = body mass index; TIA/CVA = transient ischemic attack/cerebral vascular incident.

PFA lesions may not undergo the same degree of progressive remodeling over time vs RFA lesions, and it is more likely that ERAT after PFA reflects incomplete lesion sets or gaps rather than reversible inflammatory processes or, in some patients, is related to untargeted nonpulmonary vein triggers.[7,8,21]

In addition, our study explored whether persistence of ERAT requiring cardioversion would impact late arrhythmia recurrences and was the first to conduct such an assessment in a PFA cohort. The study found that ERAT was associated with LRAT irrespective of whether the ERAT persisted and required cardioversion, with a slightly lower HR in the DCCV group compared with the non-DCCV group, a difference that did not reach statistical significance ($P = 0.29$), likely reflecting the small size of this subgroup (n = 88). These findings are consistent with postthermal ablation findings, which showed that 84% of patients requiring cardioversion within 90 days experienced late recurrence.[22] This signals that ERAT is less likely to reflect a transient

FIGURE 5 Freedom From Arrhythmia By Month of First ERAT



Kaplan-Meier curves showing 1-year freedom from atrial arrhythmia in patients with ERAT occurring in month 1, month 2, or month 3 after pulsed field ablation, compared with patients without ERAT during the 90-day blanking period. Log-rank $P < 0.001$ vs no ERAT. Abbreviation as in Figure 1.

TABLE 5 Multivariable-Adjusted Hazard Ratios for Late Arrhythmia Recurrence By Month of First ERAT Occurrence and Cardioversion Status, With No ERAT as Reference

	Univariable			Multivariable		
Patient Group	HR	95% CI	*P* Value	HR	95% CI	*P* Value
No Arrhythmia during first 3 mo (1,274)		(Reference)				
ERAT within first 3 mo (334)	5.19	4.33-6.20	<0.001	4.89	4.04-5.93	<0.001
ERAT in month 1 (189)	5.83	4.72-7.20	<0.001	5.40	4.31-6.76	<0.001
ERAT in month 2 (72)	4.40	3.21-6.03	<0.001	3.93	2.84-5.45	<0.001
ERAT in month 3 (73)	4.91	3.61-6.67	<0.001	4.83	3.49-6.69	<0.001
ERAT during first 90 d + DCCV (88)	6.93	2.85-16.8	<0.001	4.17	3.11-5.60	<0.001
ERAT during first 90 d without DCCV (246)	7.93	4.21-14.91	<0.001	5.24	4.25-6.48	<0.001

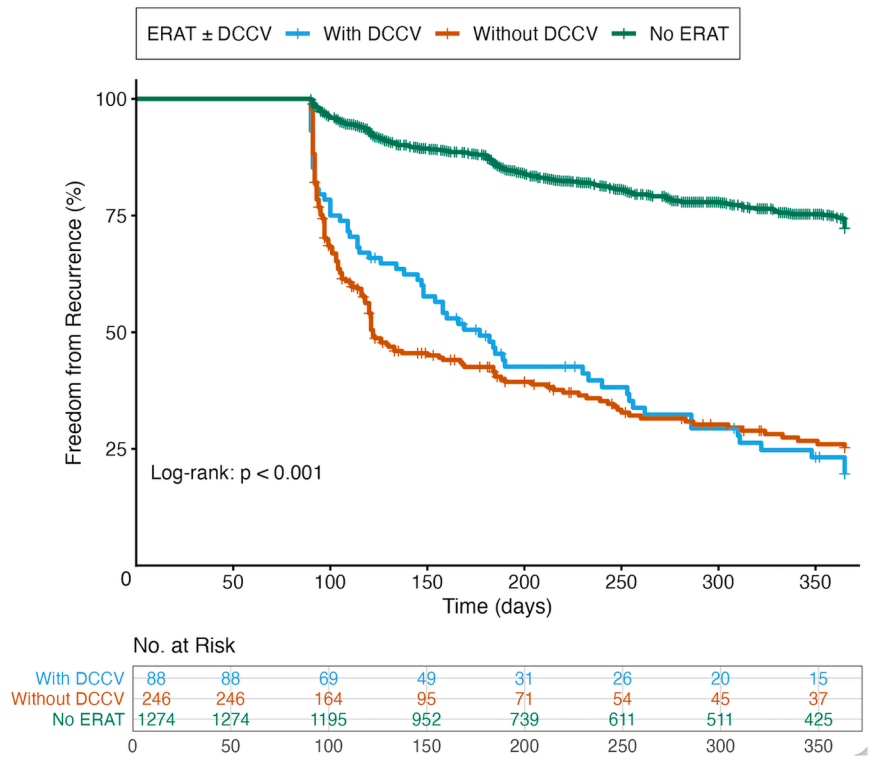
DCCV = direct current cardioversion; ERAT = early recurrence of atrial tachyarrhythmia.

substrate, in contrast to inflammation and further substrate remodeling post RFA.[7,21]

These findings have important clinical implications. ERAT after PFA, regardless of timing within the first 90 days, should prompt heightened clinical surveillance and individualized arrhythmia management, rather than being dismissed as a transient phenomenon. Although the majority of patients with ERAT experienced late recurrence (68.4%), approximately one-third (31.6%) did not, indicating that ERAT represents a strong prognostic marker warranting increased monitoring intensity, rather than an automatic designation of treatment failure.

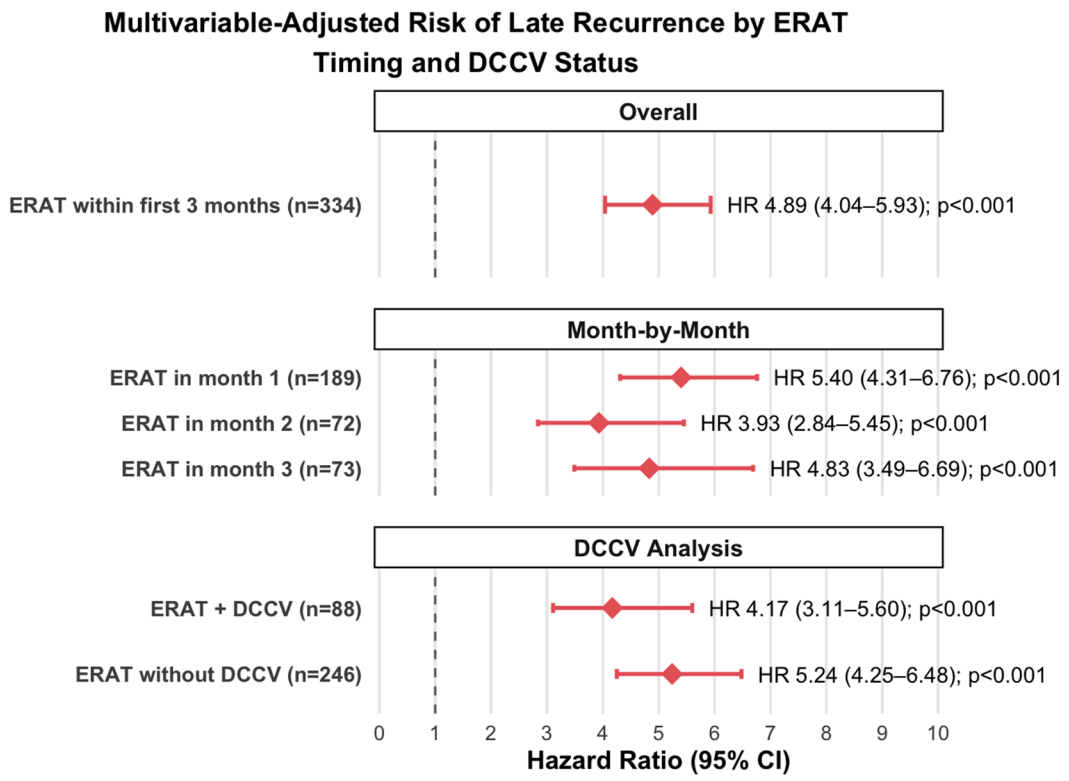
STUDY LIMITATIONS. This study has the inherent limitations of observational research, though data

FIGURE 6 Freedom From Arrhythmia By ERAT and Cardioversion Status



Kaplan-Meier curves showing 1-year freedom from atrial arrhythmia grouped by ERAT status and direct current cardioversion (DCCV) requirement during the 90-day blanking period after pulsed field ablation. Log-rank $P < 0.001$ vs no ERAT; other abbreviation as in Figure 1.

FIGURE 7 Late Recurrence Hazard Ratios By ERAT Timing and Cardioversion Status



Forest plot showing multivariable-adjusted HRs for late arrhythmia recurrence by month of first ERAT occurrence and by DCCV status during the blanking period after pulsed field ablation, with no ERAT as the reference group. Error bars represent 95% CIs. Abbreviations as in Figure 6.

were prospectively collected in a dedicated AF registry. It reflects the experience of a single high-volume tertiary referral center with experienced operators and may not be generalizable to lower-volume programs, centers with less PFA experience, or all PFA platforms, particularly as most procedures were performed using the Farapulse system.

The study is limited by the absence of systematic AF burden assessment, as not all patients had continuous rhythm monitoring throughout follow-up. Arrhythmia recurrence was defined using the conventional threshold of atrial tachyarrhythmia lasting ≥30 seconds, which may not fully capture clinically meaningful arrhythmia burden. In addition, monitoring intensity was not uniform across the first 3 months after ablation: 2-week continuous ambulatory monitoring was performed early, whereas months 2 and 3 relied on scheduled and symptom-triggered evaluations. This heterogeneity may have increased detection of first-month ERAT and should be considered when interpreting month-by-month comparisons.

Patients with ERAT may also have undergone more intensive follow-up and rhythm monitoring after the blanking period, which could have increased detection of late recurrence. Therefore, although the magnitude of the observed association supports the prognostic importance of ERAT, a contribution from differential surveillance intensity cannot be excluded. Detailed postablation antiarrhythmic drug dosing and duration data were not prospectively captured for all patients; however, sensitivity analyses stratified by baseline antiarrhythmic drug use demonstrated consistent findings across subgroups. Left atrial size was not uniformly available and therefore could not be included in multivariable analyses. Finally, the study did not include a medical

CENTRAL ILLUSTRATION **Impact of Early Atrial Tachyarrhythmia Within the Blanking Period on Late Recurrence After PFA of AF**

Population

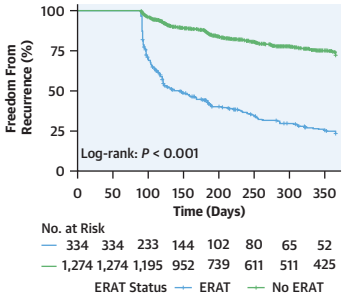
- Cleveland Clinic Cohort
- Feb 2024-May 2025
- Pulsed-Field Ablation
- 1 year Follow-up

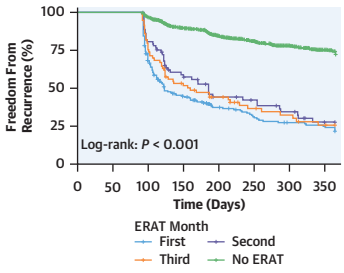
N = 1,608

Early Recurrence (ERAT) N = 334

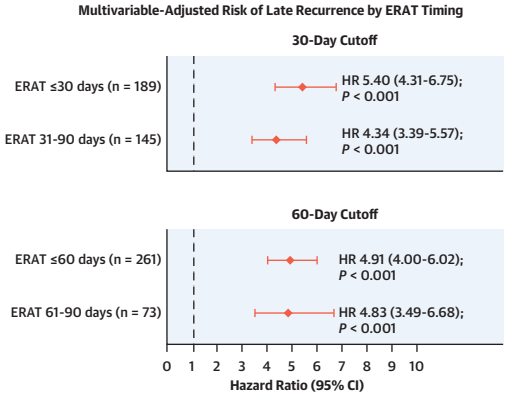
Without ERAT N = 1,274

Results





- **ERAT** was independently associated with LRAT (HR 4.89, 95% CI: 4.04-5.93; $P < 0.001$)
- Using **30-day** or **60-day** cutoffs, ERAT remained strongly associated with LRAT



Reference group: No ERAT (n = 1,274). All hazard ratios are compared to the no ERAT reference group.

- After PFA for AF, any atrial tachyarrhythmia within 3 months regardless of timing or cardioversion, strongly predicts late recurrence, warranting increased monitoring intensity in the early post-ablation period

Dakik A, et al. JACC Clin Electrophysiol. 2026;■(■):■-■.

Among 1,608 patients undergoing pulsed field ablation (PFA) for atrial fibrillation (AF) at Cleveland Clinic (February 2024-May 2025) with 1-year follow-up, 334 developed early recurrence of atrial tachyarrhythmia (ERAT) within the 90-day blanking period. ERAT was independently associated with late arrhythmia recurrence (LRAT) (HR: 4.89; 95% CI: 4.04-5.93; $P < 0.001$), and this association remained strong using both 30-day and 60-day timing cutoffs. These findings indicate that ERAT strongly predicts late recurrence regardless of timing, warranting increased monitoring intensity in the early postablation period.

management control group, and whether early repeat ablation or other management escalation improves outcomes in patients with ERAT after PFA warrants prospective investigation.

CONCLUSIONS

In this large prospective cohort of patients undergoing pulsed field ablation for AF, early atrial tachyarrhythmia recurrence was strongly associated with late recurrence regardless of timing within the traditional 90-day blanking period. Neither a 30-day nor a 60-day cutoff meaningfully affected prognosis, and month-by-month stratification demonstrated consistently elevated risk of arrhythmia recurrence. “These findings underscore the value of ERAT as a prognostic marker with important implications for post-ablation monitoring intensity.”

PERSPECTIVES

COMPETENCY IN MEDICAL KNOWLEDGE: In this large prospective cohort of patients undergoing PFA for atrial fibrillation, ERAT was strongly associated with late recurrence regardless of timing within the traditional 90-day blanking period. Neither a 30-day nor a 60-day cutoff meaningfully affected prognosis, and month-by-month stratification demonstrated consistent risk of arrhythmia recurrence.

TRANSLATIONAL OUTLOOK: Early arrhythmias occurring within 3 months from PFA of atrial fibrillation identify patients at substantially increased risk of late recurrence and should prompt heightened surveillance. Whether specific treatment interventions in patients with ERAT after PFA improve long-term outcomes remains unknown and warrants dedicated prospective investigation.

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KEY WORDS **atrial fibrillation, blanking period, catheter ablation, early recurrence, pulsed field ablation, pulmonary vein isolation**

APPENDIX **For a supplemental figure, please see the online version of this paper.**