Supplementary Table 1. Baseline characteristics of the included studies (PFA vs thermal ablation).

Author (year)	Country	Study design	Study Population	Total participants (n)	Age (years)	Male (%)	BMI (kg/m^2)	Paroxysmal AF (%)	Persistent AF (%)	Hypertension (%)	Diabetes mellitus (%)	Stroke/TIA (%)	CAD (%)	Heart failure (%)	AADs usage (%)	LA size	LVEF (%)	CHA2DS2-VASc score	Definition of recurrences	Monitoring methods	Follow-up duration (months)	NOS
parative																						
Blockhaus (2023)[16]	Germany	Comparative, single-centre, non-randomized retrospective observational study	Patients with AF who were previously selected for pulmonary vein isolation ablation	43 (23 vs 20)	57.1±10.3 vs 59.1±8.9	65.2 vs 80	28.1±3.6 vs 26.3±3.8	52.2 vs 50	47.8 vs 50	65.2 vs 40	NR	0 vs 10	8.7 vs 25	13.1 vs 25	27.2 vs 27.5	Diameter: 41.2±3.1 mm vs 41±2.8 mm	55.7±7.6 vs 55±8.1	1.5±1.1 vs 1.7±1.3	NR	Standard ECG and a 24-h Holter ECG monitoring	12	9
Cochet (2021)[17]	France	Comparative, single-centre, non-randomized prospective observational study	Patients with paroxysmal AF referred for first catheter ablation procedure without contraindication to gadolinium-enhanced CMR	41 (18 vs 23)	58±9 vs 59±9	83 vs 74	Obesity: 22 vs 4	100	0	22 vs 17	6 vs 0	11 vs 4	6 vs 9	NR	78 vs 74	NR	62±6 vs 61±8	NR	NR	Baseline, within 3-h post-ablation, and 3-month CMR imaging	3	8
Kuroki (2020)[18]	United States and Czech Republic	Comparative, single-centre, non-randomized prospective observational study	Patients with symptomatic paroxysmal AF resistant to AAD, LVEF >40% and LA diameter <5.5 cm or LA diameter <5 cm	80 (37 vs 43)	58.9±10.1 vs 61.9±9.4	75.7 vs 72.1	NR	100	0	62.2 vs 46.5	10.8 vs 4.7	5.4 vs 7	0 vs 14	NR	NR	Diameter: 41.2±3.9 mm vs 37.9±7 mm	63±3.4 vs 60.4±5.8	NR	NR	Baseline and 3-month cardiac computed tomography scan	3	7
Maurhofer (2023)[19]	Switzerland	Comparative, single-centre, non-randomized prospective	Patients undergoing a first PVI for paroxysmal AF	200 (40 vs 160)	62.5±9.3 vs 62.5±12.1	75 vs 75.7	25.9±4.1 vs 26.3±3.5	100	0	65 vs 61.5	7.5 vs 10.5	5 vs 7.5	20 vs 15	NR	NR	Diameter: 41.7±5.4 mm vs 41±7.4 mm	58.3±3.9 vs 60.3±7.1	2±1.5 (Overall)	Recurrence of any atrial tachyarrhythmia ≥ 30 s (AF, AFL, or AT) between day 91 and 365 post-	7-day Holter ECG were scheduled at 3, 6, and 12 months after PVI	12	9

		observational study																	ablation after the standard blanking period of 90 days			
Nakatani (2021)[20]	France	Comparative, single-centre, non-randomized prospective observational study	Patients with paroxysmal AF referred for first catheter ablation procedure without contraindication to gadolinium-enhanced CMR	41 (18 vs 23)	56±9 vs 60±8	83 vs 74	26±4 vs 26±3	100	0	22 vs 17	6 vs 0	6 vs 4	6 vs 9	0 vs 4	72 vs 78	Volume: 74.7±15.1 mL vs 77.3±11.5 mL	62±6 vs 61±8	0.5±0.4 vs 0.7±0.8	AF and atrial tachycardia episodes lasting ≥30 s after 3 months post-ablation	A 12-lead surface ECG was performed at each visit, and 24-h Holter monitoring was performed in case of symptoms	9	9
Reddy (2023)[21]	Multi-centre international study	Comparative, multi-centre, randomized prospective observational study	Adults with symptomatic paroxysmal AF that was refractory to at least one AADs (class I, II, III, or IV), LVEF >40% and LA diameter <5.5 cm	607 (305 vs 302)	62.4±8.7 vs 62.5±8.5	66.2 vs 64.6	28.3±4.6 vs 29±4.8	100	0	57 vs 52.6	10.8 vs 10.6	3.9 vs 5	10.5 vs 16.9	19.3 vs 19.5	98.7 vs 99.3	NR	NR	1.7±1.2 vs 1.7±1.2	Documented atrial tachyarrhythmia lasting 30 seconds or longer after the 3-month blanking period	72-hour Holter monitoring was performed at 6 and 12 months, and trans-telephonic ECG recordings were obtained weekly after the blanking period and for any symptoms	12	9
Schipper (2023)[22]	Germany	Comparative, single-centre, non-randomized retrospective observational study	All consecutive patients undergoing first PVI in the setting of paroxysmal and persistent AF	108 (54 vs 54)	69±11 vs 67±13	69 vs 69	27.8±5 vs 28.1±4.5	30 vs 31	70 vs 69	72 vs 69	17 vs 17	NR	31 vs 26	NR	33 vs 28	Diameter: 38.8±5.8 mm vs 39.6±6.1 mm	53.3±10.9 vs 54.9±10.6	3±1.8 vs 2.7±1.7	NR	24-h Holter ECG	12	8
Urbanek (2023)[23]	Germany	Comparative, single-centre, non-randomized	Patients with symptomatic AF (either paroxysmal or persistent AF)	400 (200 vs 200)	67.7±14.2 vs 70±11.2	54 vs 59	27.7±4.5 vs 27.3±5.2	63.5 vs 58	36.5 vs 42	70.5 vs 66	16.5 vs 14	7.5 vs 5	13.5 vs 14	11.5 vs 13.5	NR	Diameter: 40±5.9 mm vs 41.3±	NR	2.7±2.2 vs 2.7±1.5	Recurrence of atrial tachyarrhythmias >30 s after a 3-month	A 6- and 12-month clinical control, including a 72-hour Holter ECG	12	8

		retrospective observational study														6.7 mm			blanking period			
Wörmann (2023)[24]	Germany	Comparative, single-centre, non-randomized retrospective observational study	All consecutive patients undergoing de novo CA for symptomatic paroxysmal or persistent AF	114 (57 vs 57)	67±13 vs 67±12	33 vs 40	28±5 vs 27±4	30 vs 30	70 vs 70	65 vs 60	16 vs 14	NR	25 vs 19	NR	28 vs 23	Diameter: 39.6±6 mm vs 38±3.5 mm	56±6 vs 56±9	3 vs 3	Any detected atrial arrhythmia (AF, AFL, AT) >30 s was defined as recurrence of arrhythmia after a 90 days blanking period	48-h Holter ECG	12	8
e-Arm																						
Duytschaever (2023)[25]	Multi-centre international study	Single-arm, multi-centre, prospective observational study	Subjects with drug-refractory, symptomatic paroxysmal AF	186	59.4±10.2	70.4	27.6±4.3	100	0	46.2	7	3.8	5.9	2.2	NR	38±5.1	60.8±5.8	1.3±1.2	Documented symptomatic AF/AFL/AT of ≥30 s duration after 3 months blanking period	24-hour Holter monitoring (at 3, 6, and 12 months)	12	9
Füting (2022)[26]	Germany	Single-arm, single-centre, prospective observational study	Patients with documented, symptomatic, paroxysmal (duration ,7 days) atrial fibrillation who were either refractory or intolerant to a Class I or III antiarrhythmic agent	30	63±10	47	29±4	100	0	63	0	3	13	NR	50	43±6	60±6	2±1	NR	NR	3	8
Gunawardene (2021)[27]	Germany	Single-arm, single-centre, prospective observational study	Patients eligible for catheter ablation of atrial fibrillation, including paroxysmal and persistent atrial fibrillation	11	75.2±6.2	54.5	25.9±5.3	77.8	22.2	81.8	NR	NR	NR	NR	NR	45.2±4.1	NR	3±1.5	NR	NR	3	8

Lemoine (2023)[28]	Multi-centre international study	Single-arm, multi-centre, prospective observational study	Patients with symptomatic paroxysmal or persistent AF who underwent PVI	138	67±12	65.9	28±6	37.7	62.3	65.2	16.7	4.3	18.8	24.6	18.8	43±5	52±10	2.6±1.7	Any episode of AF, AT, AFL as documented in 12-lead ECG or in Holter ECG >30 s was considered a recurrence	12-lead ECG or in Holter ECG >30 s	12	8
Loh (2020)[29]	Netherlands	Single-arm, single-centre, prospective observational study	Symptomatic paroxysmal or persistent AF qualifying for PVI	10	59±11	70	NR	60	40	40	NR	NR	20	NR	90	33±7	NR	1.6±1.4	Atrial tachyarrhythmias (unspecified)	12-lead ECG	7	7
Reddy (2020)[30]	Multi-centre international study	Single-arm, multi-centre, prospective observational study	Patients with documented symptomatic persistent AF refractory or intolerant to at least 1 Class I/III AADs	25	65.7±7.9	80	NR	0	100	72	12	5	0	12	34.1	44±4	58.7±11	NR	NR	NR	3	8
Reddy (2021)[31]	Multi-centre international study	Single-arm, multi-centre, prospective observational study	Patients with symptomatic paroxysmal AF resistant to at least 1 class I to IV AADs, with LVEF >40% and LA diameter <5.5 cm for Trial 1 or LA diameter <5 cm	49	56.9±10.4	65.3	NR	100	0	59.2	6.1	6.1	4.1	NR	100	40±5	61.2±7.2	NR	Recurrence of AF, AT, or AFL after the 90-day blanking period	Transtelephonic ECG transmissions as well as 24-h Holter monitoring	12	9
Schmidt (2022)[32]	Multi-centre international study	Single-arm, multi-centre, prospective observational study	Patients with symptomatic AF refractory to treatment of at least 1 AADs undergoing first time ablation	191	69±12	58	28±5	62	38	67	14	5	12	9	93	42±7	60±10	NR	Recurrence was defined as any documented atrial tachyarrhythmia episode lasting >30 seconds	72-hour Holter ECG	3	8
Schmidt	Multi-centre intern	Single-arm, multi-	All patients who underwent a catheter ablation	1233	66±11	61	28±5	60	40	54	11	6	12	17	45	NR	57±10	2.3±1.6	Any episode of AT or AF	24 to 120 h Holter monitoring	12	9

(2023)[33]	ational study	centre, prospective observational study	procedure were consecutively included in the analysis. No specific inclusion and exclusion criteria were defined.															lasting more than 30 s			
Tilz (2023)[34]	Germany	Single-arm, single-centre, prospective observational study	Patients with symptomatic AF undergoing PFA	50	63.6± 10.7	62	25.8± 6.4	56	44	66	10	6	NR	18	82	40±7.4	NR	1.7±1.4	Recurrence of AF after the 3-months blanking period	24-hour Holter ECG	6	8
Verma (2023)[14]	Multi-centre international study	Single-arm, multi-centre, prospective observational study	Patients with recurrent symptomatic paroxysmal or persistent AF who failed or did not tolerate treatment with ≥1 class I or III AADs	300	64.7± 9.5	69.5	29.8± 6.4	50	50	57	15	2.8	21	NR	62	40.4± 5.4	58.9± 5.6	NR	Documented atrial arrhythmia recurrence of ≥30 seconds after the 90-day blanking period	12-lead ECGs and 24-hour Holter monitoring	12	9

AADs: antiarrhythmic drugs; AF: atrial fibrillation; AFL: atrial flutter; AT: atrial tachycardia; BMI: body mass index; CA: catheter ablation; CAD: coronary artery disease; CMR: cardiac magnetic resonance; ECG: electrocardiogram; LA: left atrium; LVEF: left ventricular ejection fraction; mL: millilitres; mm: millimetres; NOS: Newcastle-Ottawa Scale; NR: not reported; PFA: pulsed field ablation; PVI: pulmonary vein isolation; TIA: transient ischemic attack.

Supplementary Table 2. Baseline procedural characteristics.

No.	Author (year)	PFA power, waveform, and catheter type	PFA additional characteristics	Additional ablation beyond PVI (PFA)	Control (Thermal ablation)	Catheter type	Thermal ablation additional characteristics	Additional ablation beyond PVI (Thermal ablation)
Comparative								
1	Blockhaus (2023)[16]	2000 V, NR, FARAWAVE	8 applications (four times the “basket configuration” and four times the “flower configuration”)	LAPW (4%) (accidentally)	Cryoablation	28-mm cryoballoon (2nd generation, Arctic Front Advance, Medtronic, USA)	Duration protocol was 240 s per freeze	NR

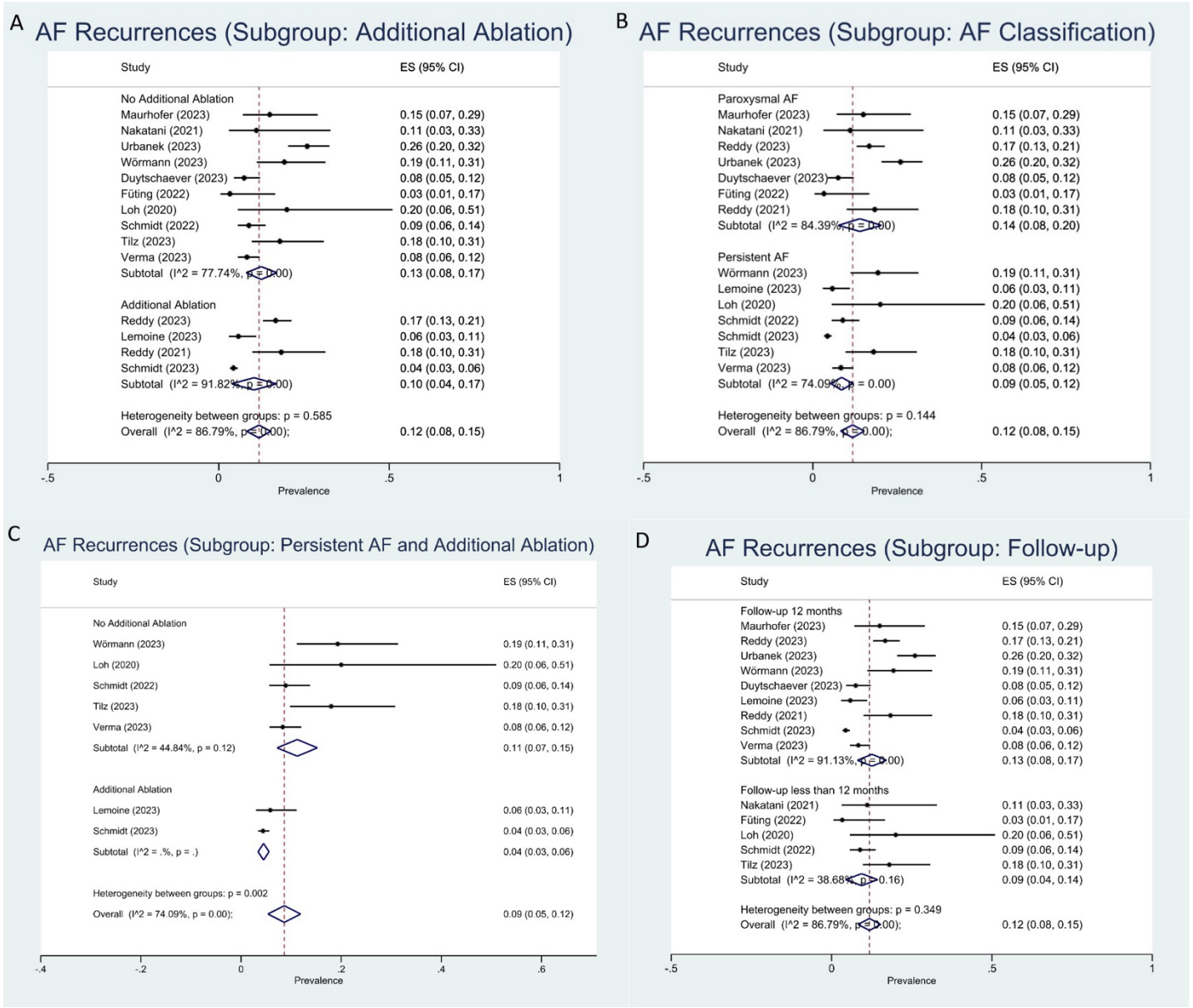
2	Cochet (2021)[17]	1800-2000 V, Biphasic, FARAWAVE	Applications were repeated eight times per vein, with repositioning and/or rotation of the catheter every two applications to ensure circumferential PV ostial and antral coverage	NR	RFA (69.6%) and cryoablation (30.4%)	**RFA:** Contact-force irrigated RF ablation catheter (THERMOCOOL SMARTTOUCH, Biosense Webster). **CA:** 28-mm cryoballoon catheter (Arctic Front Advance, Medtronic)	**RFA:** When using RF, we applied 0.9% saline irrigation, and delivered RF during 30-60 s applications, with a temperature limited to 52ºC, a minimum contact force of 20 g on the anterior wall and 10 g on the posterior wall, and a maximum power of 30 W (25 W on the posterior wall). **CA:** A minimum of two freezes were delivered to each PV with a targeted duration of 180 s	LAPW (100%)
3	Kuroki (2020)[18]	900-1000 V (Biphasic) or 1800-2000 V (Monophasic), FARAWAVE	NR	NR	RFA	Contact-force sensing TactiCath catheter (St. Jude Medical) in the experimental arm of TOCCASTAR or the THERMOCOOL NAVISTAR catheter (Biosense Webster)	NR	NR
4	Maurhofer (2023)[19]	1900-2000 V, Biphasic, FARAWAVE	PVI was performed with four applications in basket and four applications in flower configuration per PV as previously described to complete the standard 32-applications lesion-set	0	RFA (50%) and cryoablation (50%)	**RFA:** Contact-force sensing ablation catheter (Smarttouch SF, Biosense Webster, Irvine, CA, USA). **CA:** a 28-mm cryoballoon catheter (Arctic Front Advance)	**RFA:** Power settings were at the discretion of the operator and ranged from 30 to 50 Watts. **CA:** In case of an effective freeze (judged by the disappearance of all local PV signals before 60 s or reaching a temperature of − 40°C) cryoablation was continued for two additional minutes after effect (“time-to-effect plus 2-min strategy”)	0
5	Nakatani (2021)[20]	1800-2000 V, Biphasic, FARAWAVE	Applications were repeated eight times per vein, with repositioning and/or rotation of the catheter every two applications to ensure circumferential PV ostial and antral coverage	NR	RFA (69.6%) and cryoablation (30.4%)	**RFA:** an irrigated tip RF catheter with a contact force sensor (Thermocool Smarttouch SF, Biosense-Webster, Inc.). **CA:** a 28-mm cryoballoon catheter (Arctic Front Advance, Medtronic Minneapolis, MN, USA)	**RFA:** We delivered RF during 15-30 s applications, with a temperature limited to 52ºC and a maximum power of 45 W. **CA:** A minimum of two freezes were delivered to each PV with a targeted duration of 180 s	NR

6	Reddy (2023)[21]	NR, Biphasic, FARAWAVE	NR	CTI: 23%	RFA (55.3%) and cryoablation (44.7%)	**RFA:** Saline-irrigated force sensing radiofrequency ablation catheter or **CA:** 23-mm or 28-mm cryoballoon catheter (2nd generation, Arctic Front Advance, Medtronic)	NR	CTI: 28.5%
7	Schipper (2023)[22]	NR, NR, FARAWAVE	At every PV antrum, 4 PFA impulses were delivered in the “basket” and “flower” configuration of the catheter, respectively. The delivery of more PFA applications was at operators' discretion.	NR	Cryoablation	The 31-mm POLARx™ cryoablation system (Boston Scientific)	The duration of freezes was determined by either the time-to-isolation (TTI), abolishment of PV potentials if displayed on the circumferential mapping catheter (POLARMAP™) or by reaching nadir temperature. If TTI was within 60 s, a freeze of 180 s was applied. In case TTI was achieved after 60 s, a longer freeze of 240 s was administered	NR
8	Urbanek (2023)[23]	2000 V, Biphasic, FARAWAVE	Each vein was treated with 8 energy applications, 4 in flower and 4 in basket configurations (2.5 s per application)	CTI was excluded	Cryoablation	Second-generation CB (CB2, 28-mm Arctic Front Advance; Medtronic)	Freeze duration was set at 240 s, and no bonus application was delivered if a time to isolation was observed in the first 75 s of freeze	CTI was excluded
9	Wörmann (2023)[24]	NR, NR, FARAWAVE	At every PV antrum, 8 PFA impulses were delivered in the “flower” and “basket” configuration of the catheter	NR	VHPSD	A non contact-force ablation catheter with enhanced tip irrigation (20 mL/min)	For circumferential PVI a power setting of 70 W for 7 s was used at all sites except for the posterior wall where RF duration was reduced to 5 s	LAPW: 100%
Single-Arm								
10	Duytschaever (2023)[25]	1800 V, Biphasic, FARAWAVE	12 applications per PV	NR	N/A	N/A	N/A	N/A
11	Füting (2022)[26]	1800 V, Biphasic, FARAWAVE	Eight applications per vein	NR	N/A	N/A	N/A	N/A
12	Gunawardene (2021)[27]	1900 V, Biphasic, FARAWAVE	Eight applications per vein	NR	N/A	N/A	N/A	N/A
13	Lemoine (2023)[28]	1800-2000 V, Biphasic, FARAWAVE	At every PV, 8 PFA impulses were delivered in the “flower” and “basket” configuration of the catheter	LAPW: 1/138; CTI: 4/138	N/A	N/A	N/A	N/A

14	Loh (2020)[29]	2000 V, Biphasic, FARAWAVE	NR	NR	N/A	N/A	N/A	N/A
15	Reddy (2020)[30]	1600-2000 V, Biphasic, FARAWAVE	4 paired applications per vein, that is, 2 applications each in the flower and basket poses	LAPW: 24/25; CTI: 13/25	N/A	N/A	N/A	N/A
16	Reddy (2021)[31]	1800-2000 V, Biphasic, FARAWAVE	The number of pulses varied from 4 to 10 for each application	CTI: 4/49	N/A	N/A	N/A	N/A
17	Schmidt (2022)[32]	1800-2000 V, Biphasic, FARAWAVE	8 energy applications were delivered at each PV	NR	N/A	N/A	N/A	N/A
18	Schmidt (2023)[33]	1800-2000 V, Biphasic, FARAWAVE	NR	LAPW: 127/1233; CTI: 6/1233	N/A	N/A	N/A	N/A
19	Tilz (2023)[34]	2000 V, Biphasic, FARAWAVE	8 pulse trains (4×basket/flower configuration each) were delivered to each PV starting with the left-sided veins	NR	N/A	N/A	N/A	N/A
20	Verma (2023)[14]	1400-1500 V, Biphasic, FARAWAVE	One application was defined as 4 biphasic, bipolar pulse trains. After each application, the catheter was rotated circumferentially to a new position to achieve full circumferential isolation	NR	N/A	N/A	N/A	N/A

CA: catheter ablation; CF: contact-force; CTI: cavotricuspid isthmus; g: grams; LAPW: left atrial posterior wall; mm: millimetres; N/A: not available; NR: not reported; PFA: pulsed field ablation; PV: pulmonary vein; PVI: pulmonary vein isolation; RFA: radiofrequency ablation; s: second; V: Volt; W: Watt.

Supplementary Figure 1



(A) Incidence of AF recurrences in PFA group based on additional ablation beyond PVI, (B) AF classification, (C) solely persistent AF subgroup based on additional ablation beyond PVI, and (D) follow-up duration.