ESC European Society of Cardiology

Europace (2024) **26**, euae077
https://doi.org/10.1093/europace/euae077

RESEARCH LETTER

Focal point-by-point biphasic monopolar pulsed field ablation for posterior wall isolation

Florent Farnir [1†], Sevasti-Maria Chaldoupi [1†], Frédéric Farnir [2], Ulrich Schotten [1], Kevin Vernooy [1], Justin Luermans [1], and Dominik Linz [1,3]*

[1]Department of Cardiology, Cardiovascular Research Institute Maastricht (CARIM), Maastricht University Medical Centre, Universiteitssingel 50, 6229 ER Maastricht, The Netherlands; [2]Department of Biostatistics and Bioinformatics, FARAH, Faculty of Veterinary Medicine, University of Liege, Liege, Belgium; and [3]Department of Biomedical Sciences, Faculty of Health and Medical Sciences, University of Copenhagen, Blegdamsvej 3B, 2200 Copenhagen, Denmark

Received 17 February 2024; accepted after revision 19 March 2024; online publish-ahead-of-print 22 March 2024

Keywords Atrial fibrillation • Pulsed field ablation • Focal ablation • Posterior wall isolation • First-pass isolation

The cornerstone of rhythm control by atrial fibrillation (AF) ablation is pulmonary vein isolation (PVI), which is less effective in persistent AF compared with paroxysmal AF.[1] In an attempt to improve outcomes in patients with persistent AF, the posterior wall has been targeted as an adjunctive strategy.[2] However, when using radiofrequency ablation (RFA), successful posterior wall isolation (PWI) cannot be achieved in all patients, and the acute procedural success rate is low (~70%).[2] Additional, empiric PWI using RFA did not reduce atrial arrhythmia recurrence in the CAPLA study comparing PVI vs. PVI + PWI in patients with persistent AF.[3]

In comparison to RFA, pulsed field ablation (PFA) is a novel non-thermal ablation technology consisting of a high-voltage train with very short pulses,[4] which results in transmural tissue-specific damage in the heart by cardiomyocyte selective electroporation without thermal damage of surrounding organs. Recent studies, mainly utilizing a bipolar pentaspline single-shot PFA device, have demonstrated safety and efficacy for PWI.[5–8] In this prospective cohort study, we evaluated the feasibility, acute efficacy, and acute safety of PWI by point-by-point biphasic monopolar focal PFA (F-PFA) using the CENTAURI PFA system (CardioFocus, Inc.).[9–11]

Thirty-eight patients with persistent AF (mean age 67.3 ± 7.7 years, 58% men, 9 first-do ablations, and 29 complex re-do AF ablations), who underwent PWI using the CENTAURI PFA system (CardioFocus, Inc.), were included in this analysis. This study was approved by the local ethical review board (NL:70787.068.19/METC:19-052), and all participants provided written informed consent.

Electroanatomic mapping was performed with a high-density mapping catheter (PentaRay catheter, Biosense Webster; HD-Grid catheter, Abbott) using the respective mapping systems (Carto, Biosense Webster; EnsiteX, Abbott). According to the local protocol, the decision to perform PWI was based on the goal to isolate considerable low-voltage areas (see electroanatomical maps before ablation with the projected application tags in *Figure 1*) and evoked delayed electrograms during premature atrial extrastimuli at the posterior wall.

Point-by-point monopolar F-PFA using a monopolar biphasic CENTAURI PFA generator (CardioFocus, Inc.) was delivered through commercial open irrigated contact force-sensing, solid-tip focal ablation catheters (ThermoCool SmartTouch, Biosense Webster; TactiCath, Abbott).[9–11] The ablation catheter's irrigation rate was set to 4 mL/min. Force applied was targeted between 10 and 25 *g*. Manual application tags of 6 mm diameter were placed with 20–30% overlap. As the catheter visualization in the mapping system is not active during F-PFA applications, stability of the ablation catheter was assured before and confirmed after completion of the F-PFA delivery. In first-do procedures, PVI was achieved by a wide antral circumferential ablation [WACA; a current of 22 A (7 pulse trains) for the posterior sections and 25 A (10 pulse trains) for the anterior sections]; in re-do procedures, re-isolation of the pulmonary veins was achieved by focal ablation if focal reconnection of previous WACA could be localized or by wide re-antralization. Posterior wall isolation was achieved by a posterior box ablation consisting of a floor line [22 A (7 pulse trains)] joining the most inferior margins of the right and left WACAs and of a roof line [25 A (10 pulse trains)] at the cranial aspect

* Corresponding author. Tel: +31 43 3875093. *E-mail address*: dominik.linz@mumc.nl
† The first two authors shared first authorship.

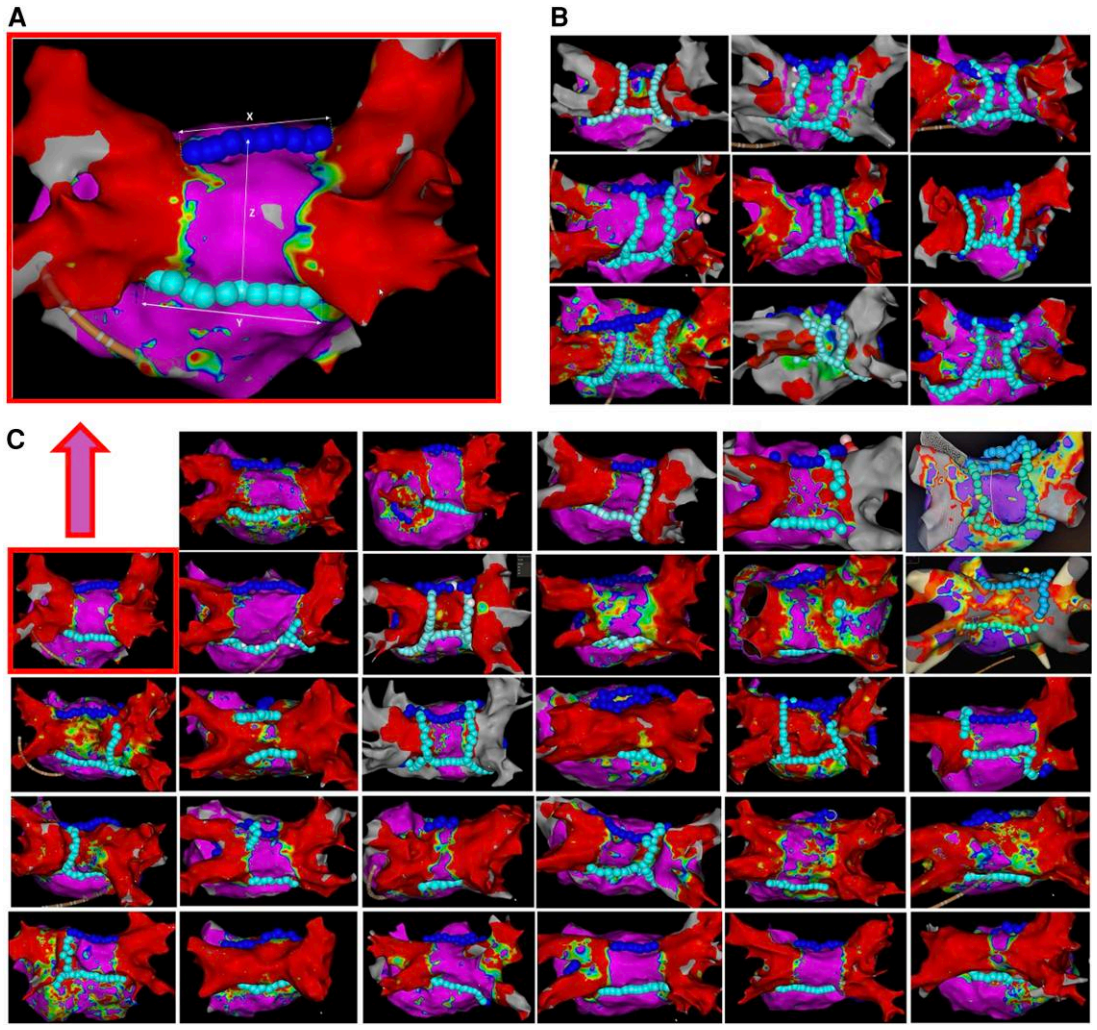

Figure 1 (*A*) Representative electroanatomical voltage maps before ablation (postero-anterior view) of the left atrium [red zones correspond to low-voltage areas (<0.15 mV), and purple zones correspond to normal-voltage areas (>0.5 mV)] with the projected ablation point tags. Dark blue points are 25 A ablation point tags and correspond to the roof line. The light blue points are 22 A ablation point tags and correspond to the floor line. *X* corresponds to the length of the roof line, *Y* to the length of the floor line, and *Z* to the interline distance. (*B*) Summary of all 9 first-do procedures and (*C*) summary of all 29 re-do procedures.

of the left atrial roof connecting the most superior margins of both WACAs. Acute PWI was the primary outcome of this study: multipolar catheters were used to assess for entry block (absence of local electrograms in the posterior box). Exit block was validated if spontaneous ectopy and/or pacing within the posterior box (pacing on ablation catheter, with local capture in the box assessed by multipolar catheter) was not associated with atrial activation. Validation was repeated after 15-min waiting time.

The median total procedure time (from femoral puncture to figure-of-eight stitch) was 120 [interquartile range 96–129] min, and the median left atrial dwell time was 87 [interquartile range 70–107] min. The mean left atrial mapping time was 16 ± 9 min, and mean fluoroscopy time and dosis were 8 ± 6 min and 34 ± 51 mGy, respectively. Posterior wall isolation (*Table 1*) was achieved in all 38 (100%) patients without the need of additional focal ablation on the ablation lines or within the posterior box after completion of floor and roof lines to obtain acute PWI. The mean time to obtain PWI (from first to last ablation point) was 12 ± 5 min. The required time for completion of the floor line was 5 [interquartile range 3–6] min. The mean length of the floor line was 33 ± 11 mm, and 10 ± 3 PFA applications were needed to complete the line. This represents 3.1 ± 0.4 PFA application/cm. The required time to complete the roof line was 5 ± 2 min. The mean length of the roof line was 29 ± 10 mm, and 9 ± 3 PFA applications were required to complete the line. This represents 3.2 ± 0.7 PFA application/cm.

Using biphasic monopolar F-PFA, PWI was achieved after completion of roof and floor lines without any need of additional lesions within the box. This is in contrast to data from studies on radiofrequency catheter ablation, where electrical isolation of the posterior box by completion of the roof and the floor line alone can only be achieved in 44–72% of cases.[2] Additionally, in the CAPLA study,[3] 86% of PWI required focal ablation within the posterior wall box to achieve electrical isolation. Biphasic monopolar F-PFA, as used in our study, has been shown to be associated with deep lesion

Table 1 Procedural data for posterior wall isolation in 38 patients (9 first-do and 29 re-do procedures) with persistent atrial fibrillation

Total ablation procedure	
Total procedure time, min	120 [IQR 96–129]
Left atrial dwell time, min	87 [IQR 70–107]
Posterior box isolation	
Total	
PWI, *n* (%)	38 (100)
PWI with completion of roof and floor lines, *n* (%)	38 (100)
Time to PWI, min	12 ± 5
PFA time, s	168 ± 53
Ablation points, *n*	19 ± 6
Inter-floor–roof line distance, mm	32 [IQR 31–35]
Floor line	
Duration, min	5 [IQR 3–6]
Ablation points, *n*	10 ± 3
Length, mm	33 ± 11
Ablation points/cm	3.1 ± 0.4
PFA time, s	72 ± 24
Roof line	
Duration, min	5 ± 2
Ablation points, *n*	9 ± 3
Length, mm	29 ± 10
Ablation points/cm	3.2 ± 0.7
PFA time, s	95 ± 35

Mean ± standard deviation. Median [IQR].
IQR, interquartile range; PFA, pulsed field ablation; PWI, posterior wall isolation.

transmurality,[12] likely deeper than with RFA, with possible ablation of epicardial connections.

In addition to the good acute effectiveness of PWI using monopolar biphasic F-PFA, time needed for PWI was short with 12 ± 5 min for the floor plus roof line, with a total PFA time of only 168 ± 53 s. This is much faster than what was reported for thermal RFA using the same ablation catheters and navigation systems, where the time needed for PWI ranged from 40 to 90 min.[2] Additionally, in 38 patients, we reported no significant complications, which is in line with the safety profile of PFA demonstrated in large PFA registries.[13–15]

In conclusion, acute PWI can be achieved effectively with a favourable acute safety profile by point-by-point biphasic monopolar F-PFA in patients undergoing catheter ablation for persistent AF. The durability and long-term efficacy and long-term safety of PWI using point-by-point biphasic monopolar F-PFA as an adjunct target in addition to PVI for the treatment of patients with persistent AF needs to be evaluated in future studies.

Acknowledgements

Tom van Rooij, PhD (employee of Biosense Webster Netherland), supported in extracting the data and provided critical feedback on the method section of this manuscript.

Funding

None declared.

Conflict of interest: none declared.

Data availability

The data underlying this article will be shared upon reasonable request to the corresponding author.

References

1. Clarnette JA, Brooks AG, Mahajan R, Elliott AD, Twomey DJ, Pathak RK *et al.* Outcomes of persistent and long-standing persistent atrial fibrillation ablation: a systematic review and meta-analysis. *Europace* 2018;**20**:366–76.
2. Thiyagarajah A, Kadhim K, Lau DH, Emami M, Linz D, Khokhar K *et al.* Feasibility, safety, and efficacy of posterior wall isolation during atrial fibrillation ablation: a systematic review and meta-analysis. *Circ Arrhythm Electrophysiol* 2019;**12**:e007005.
3. Kistler PM, Chieng D, Sugumar H, Ling LH, Segan L, Azzopardi S *et al.* Effect of catheter ablation using pulmonary vein isolation with vs without posterior left atrial wall isolation on atrial arrhythmia recurrence in patients with persistent atrial fibrillation: the CAPLA randomized clinical trial. *JAMA* 2023;**329**:127–35.
4. Sugrue A, Maor E, Del-Carpio Munoz F, Killu AM, Asirvatham SJ. Cardiac ablation with pulsed electric fields: principles and biophysics. *Europace* 2022;**24**:1213–22.
5. Gunawardene MA, Frommeyer G, Ellermann C, Jularic M, Leitz P, Hartmann J *et al.* Left atrial posterior wall isolation with pulsed field ablation in persistent atrial fibrillation. *J Clin Med* 2023;**12**:6304.
6. Kueffer T, Tanner H, Madaffari A, Seiler J, Haeberlin A, Maurhofer J *et al.* Posterior wall ablation by pulsed-field ablation: procedural safety, efficacy, and findings on redo procedures. *Europace* 2023;**26**:euae006.
7. Badertscher P, Mannhart D, Weidlich S, Krisai P, Voellmin G, Osswald S *et al.* Left atrial posterior wall isolation using pulsed-field ablation: procedural characteristics, safety, and mid-term outcomes. *J Interv Card Electrophysiol* 2024. https://doi.org/10.1007/s10840-023-01728-0. Epub ahead of print.
8. Kueffer T, Tanner H, Madaffari A, Seiler J, Haeberlin A, Maurhofer J *et al.* Posterior wall ablation by pulsed-field ablation—procedural safety, efficacy and findings on redo procedures. *Europace* 2024;**26**:euae006.
9. Anić A, Phlips T, Brešković T, Koopman P, Girouard S, Mediratta V *et al.* Pulsed field ablation using focal contact force-sensing catheters for treatment of atrial fibrillation: acute and 90-day invasive remapping results. *Europace* 2023;**25**:euad147.
10. Farnir F, Luermans J, Manusama R, den Uijl D, Chaldoupi SM, Linz D. Focal point-by-point pulsed field ablation for the treatment of atrial arrhythmias in patients with challenging anatomy where radiofrequency ablation cannot be applied: a case series. *HeartRhythm Case Rep* 2023;**10**:21–5.
11. Ruwald MH, Johannessen A, Hansen ML, Haugdal M, Worck R, Hansen J. Focal pulsed field ablation and ultrahigh-density mapping—versatile tools for all atrial arrhythmias? Initial procedural experiences. *J Interv Card Electrophysiol* 2023;**67**:99–109.
12. Verma A, Neal R, Evans J, Castellvi Q, Vachani A, Deneke T *et al.* Characteristics of pulsed electric field cardiac ablation porcine treatment zones with a focal catheter. *J Cardiovasc Electrophysiol* 2023;**34**:99–107.
13. Della Rocca DG, Marcon L, Magnocavallo M, Menè R, Pannone L, Mohanty S *et al.* Pulsed electric field, cryoballoon, and radiofrequency for paroxysmal atrial fibrillation ablation: a propensity score-matched comparison. *Europace* 2023;**26**:euae016.
14. Ekanem E, Reddy VY, Schmidt B, Reichlin T, Neven K, Metzner A *et al.* Multi-national survey on the methods, efficacy, and safety on the post-approval clinical use of pulsed field ablation (MANIFEST-PF). *Europace* 2022;**24**:1256–66.
15. Schmidt B, Bordignon S, Neven K, Reichlin T, Blaauw Y, Hansen J *et al.* EUropean real-world outcomes with Pulsed field ablatiOn in patients with symptomatic atRIAl fibrillation: lessons from the multi-centre EU-PORIA registry. *Europace* 2023;**25**:euad185.