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CLINICAL RESEARCH

Ostial vs. wide area circumferential ablation guided by the Ablation Index in paroxysmal atrial fibrillation

Pedro A. Sousa [1]*, Sérgio Barra [2], Carolina Saleiro [1], Ziad Khoueiry[3], Luís Adão [4], João Primo [5], Philippe Lagrange [3], Ana Lebreiro [4], Paulo Fonseca [5], Mariana Pereira [6], Luís Puga [1], Bárbara Oliveiros [7], Luís Elvas[1], and Lino Gonçalves [1,7]

[1]Pacing and Electrophysiology Unit, Department of Cardiology, Coimbra's Hospital and University Center, Morada: Praceta Prof Mota Pinto, Coimbra 3000-075, Portugal; [2]Department of Cardiology, Hospital da Luz Arrábida, V. N. Gaia, Portugal; [3]Department of Cardiology, Clinique Saint Pierre, Perpignan, France; [4]Department of Cardiology, University Hospital Center of São João, Porto, Portugal; [5]Department of Cardiology, Vila Nova de Gaia and Espinho Hospital Center, V. N. Gaia, Portugal; [6]Biosense Webster, Portugal; and [7]ICBR, Faculty of Medicine, University of Coimbra, Coimbra, Portugal

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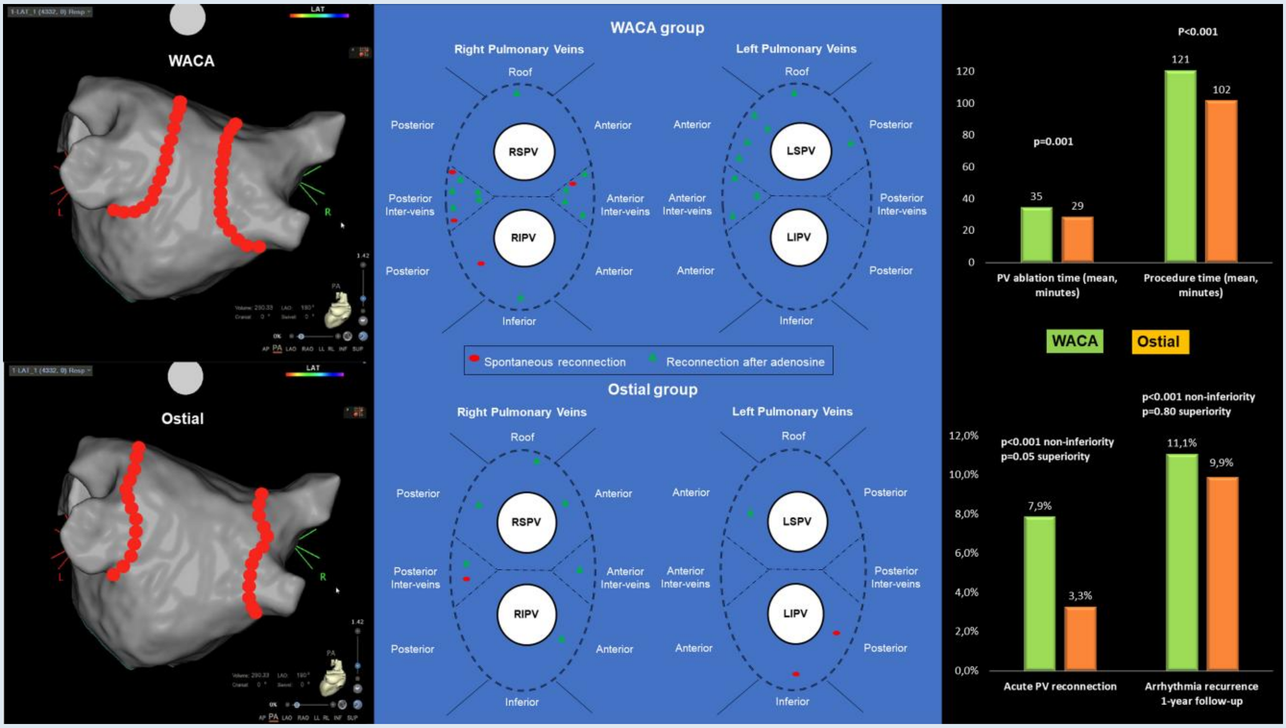
Aims Pulmonary vein isolation (PVI) guided by the Ablation Index (AI) has shown high acute and mid-term efficacy in the treatment of paroxysmal atrial fibrillation (AF). Previous data before the AI-era had suggested that wide-area circumferential ablation (WACA) was preferable to ostial ablation. However, with the use of AI, we hypothesize that ostial circumferential ablation is non-inferior to WACA and can improve outcomes in paroxysmal AF.

Methods and results Prospective, multicentre, non-randomized, non-inferiority study of consecutive patients were referred for paroxysmal AF ablation from January 2020 to September 2021. All procedures were performed using the AI software, and patients were separated into two different groups: WACA vs. ostial circumferential ablation. Acute reconnection, procedural data, and 1-year arrhythmia recurrence were assessed. During the enrolment period, 162 patients (64% males, mean age of 60 ± 11 years) fulfilled the study inclusion criteria—81 patients [304 pulmonary vein (PV)] in the WACA group and 81 patients (301 PV) in the ostial group. Acute PV reconnection was identified in 7.9% [95% confidence interval (CI), 4.9–11.1%] of PVs in the WACA group compared with 3.3% (95% CI, 1.8–6.1%) of PVs in the ostial group [$P < 0.001$ for non-inferiority; adjusted odds ratio 0.51 (95% CI, 0.23–0.83), $P = 0.05$]. Patients in the WACA group had longer ablation (35 vs. 29 min, $P = 0.001$) and procedure (121 vs. 102 min, $P < 0.001$) times. No significant difference in arrhythmia recurrence was seen at 1-year of follow-up [11.1% in WACA vs. 9.9% in ostial, hazard ratio 1.13 (95% CI, 0.44–1.94), $P = 0.80$ for superiority].

Conclusion In paroxysmal AF patients treated with tailored AI-guided PVI, ostial circumferential ablation is not inferior to WACA with regard to acute PV reconnection, while allowing quicker procedures with less ablation time.

* Corresponding author. Tel: +351 967734126. *E-mail address*: peter@chuc.min-saude.pt

Graphical Abstract



Distribution of acute pulmonary vein reconnection in both groups [wide-area circumferential ablation (WACA) vs. ostial] (central panel), with an illustration of the typical location for ablation lines in each corresponding group, in a posterior view (left panel). Ostial ablation was not inferior to WACA with regard to acute pulmonary vein reconnections ($P < 0.001$ for non-inferiority; $P = 0.05$ adjusted for superiority) and arrhythmia recurrence at 1-year of follow-up ($P < 0.001$ for non-inferiority; $P = 0.80$ for superiority), while requiring less ablation ($P = 0.001$) and allowing for quicker procedures ($P < 0.001$) (right panel).

Keywords Wide-area circumferential ablation • Ostial circumferential • Pulmonary vein isolation • Paroxysmal atrial fibrillation • Ablation Index • Acute reconnection

What's new?

- This is the first prospective study in paroxysmal atrial fibrillation (AF) ablation comparing wide-area circumferential ablation (WACA) and ostial circumferential ablation using the Ablation Index (AI) software.
- When performing tailored AI-guided pulmonary vein isolation, ostial circumferential ablation is non-inferior to WACA in preventing acute pulmonary vein reconnection, while allowing for shorter procedures.
- When using the AI, WACA does not appear to improve 1-year arrhythmia freedom after paroxysmal AF, compared with ostial circumferential ablation.

Introduction

Permanent electrical isolation of the pulmonary veins (PVs) is well established as the cornerstone of paroxysmal atrial fibrillation (AF) ablation.[1] In the latest Expert Consensus Statement on Catheter and Surgical Ablation of Atrial Fibrillation (AF) ablation, wide-area circumferential ablation (WACA) was proposed as being more effective in patients with drug-refractory paroxysmal or persistent AF as it allows substrate modification in addition to pulmonary vein isolation (PVI).[2]

Despite improvement over the recent years, the recurrence rate after PVI remains considerable, with PV reconnections being a major determinant of AF recurrence during follow-up.[3] Recently, with the use of a new software entitled 'Ablation Index' (AI) (VISITAG SURPOINT® module, Biosense Webster), high rates of long-standing PVI and high freedom from recurrent AF during follow-up have been made possible.[4–7] However, in the CLOSE protocol, AI-guided ablation was performed in the PV ostium rather than in the antrum, and the benefit of AI-guided WACA is unclear.[4] Since WACA implies longer ablation and procedure times, AI-guided ostial ablation may be preferable as long as its efficacy is not inferior.

This non-inferiority study aimed to assess whether AI-guided ostial circumferential ablation is not inferior to AI-guided WACA in both acute PV reconnection and arrhythmia recurrence during follow-up.

Methods

Study design and setting

Prospective, non-randomized, non-inferiority, multicentre study of consecutive patients referred for paroxysmal AF ablation from January 2020 to September 2021 in four tertiary hospitals. All centres have high-volume Electrophysiology Departments with similar activity volume, and procedures are carried out by experienced operators who perform >100 AF ablations per year, both ostial circumferential ablation and WACA in paroxysmal AF ablation. Participants were submitted to WACA or ostial circumferential PVI guided by the same AI target, with blinding for patients and analysts. The first 85 patients were submitted to ostial ablation, while the subsequent patients received WACA. Acute reconnection and 1-year arrhythmia recurrence were assessed in both groups.

All patients provided written informed consent, and the study was approved by the local institutional ethics committee. No patient or public was involved in the design or execution of the study.

Patient eligibility criteria

Adult patients were eligible for inclusion in this study if they had documented symptomatic paroxysmal AF refractory or intolerant to anti-arrhythmic drug (AAD) therapy. Paroxysmal AF was defined as terminating spontaneously or cardioverted within 7 days, according to the 2020 ESC Guidelines for the Management of Atrial Fibrillation developed in collaboration with EACTS.[1]

Exclusion criteria included a history of previous AF ablation, contraindication to anti-coagulation and the presence of intracardiac thrombus detected prior to the ablation procedure.

WACA group

Details of the peri-procedure management and tailored AI-guided paroxysmal AF ablation have been published previously[5,6] and are described in detail in the Supplementary material.

Briefly, left atrium (LA) anatomical and bipolar (dense scar <0.2 mV and abnormal if voltage was between 0.2 and 0.5 mV) maps were simultaneously constructed with a circular mapping catheter (LASSO® NAV eco, Biosense Webster) and integrated with a computed tomography (CT) imaging reconstruction of the LA. Wide-area circumferential ablation was performed outside a line that was created 10 mm away from the PV ostia (defined either by the electrical fusion of the PV and atrium signals or identified by three-dimensional (3D) electroanatomical reconstruction merged with the CT scan), with the exception of the ridge next to the left PVs, where the line was defined 5 mm outside the PV ostia (*Graphical Abstract* and *Figure 1*). Using a THERMOCOOL SMARTTOUCH® SF irrigated tip contact force-sensing radiofrequency (RF) ablation catheter (Biosense Webster) in a power-controlled mode with temperature limited to 43°C, ablation around PVs was performed point-by-point with a lesion tag display of 3 mm.[8] The RF lesions were contiguous with an inter-lesion distance (ILD) ≤6 mm.[4] The power settings were 30–50 W according to the region of the LA being targeted: AI target values were: ≥500 for anterior segments, ≥450 for the roof and inferior segments and ≥400 for the posterior wall.[8,9] In case of (pre-)procedural documentation of typical flutter, cavotricuspid isthmus (CTI) ablation was performed. After PVI, and without a waiting period,[6] bidirectional block was confirmed by demonstrating entry and exit blocks. Intravenous adenosine was administered to unmask sites of dormant conduction.[3] The segment containing the electrode bipole with the earliest activation was considered the most likely site of reconnection, and reconnections were targeted for ablation (*Figure 2*). Administration of further adenosine bolus after re-ablation was required to confirm successful re-isolation.

Ostial circumferential ablation group

For patients included in the ostial ablation group, a similar methodology was used as described for the WACA group. However, the encirclement ablation around PVs was performed at the ostia (defined either by the electrical fusion of the PV and atrium signals or identified by 3D electroanatomical reconstruction) with a small triangular indentation towards the vein at each anterior and posterior carina (*Graphical Abstract* and *Figure 1*).

Study endpoints

The primary endpoint was acute PV reconnection, defined as the recurrence of conduction from/to the PV after first-pass encirclement and the administration of adenosine.

Secondary endpoint included 1-year effectiveness and safety data. Effectiveness at 1-year was defined as freedom from any documented atrial

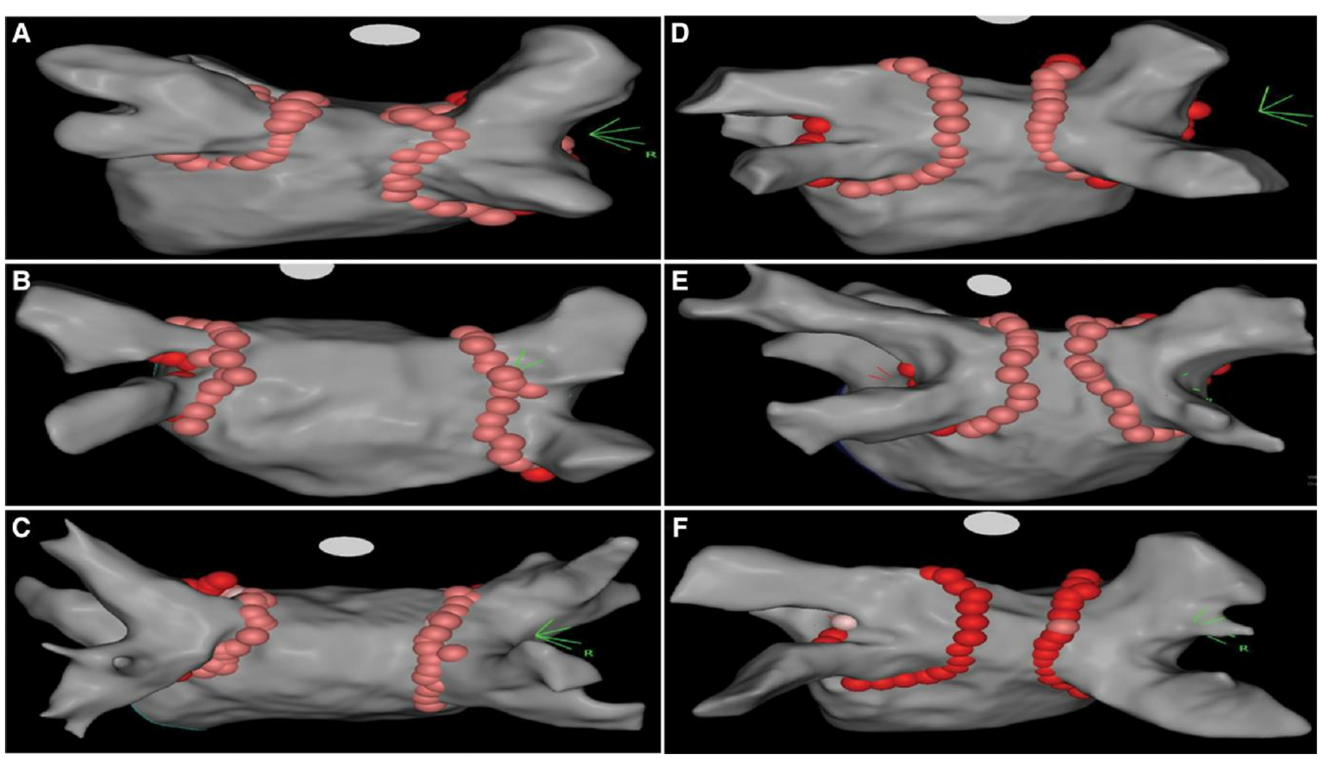


Figure 1 Examples of cases illustrating the distribution of RF lesions on both groups (*A–C* correspond to ostial ablation, while *D–F* correspond to WACA). RF, radiofrequency; WACA, wide-area circumferential ablation.

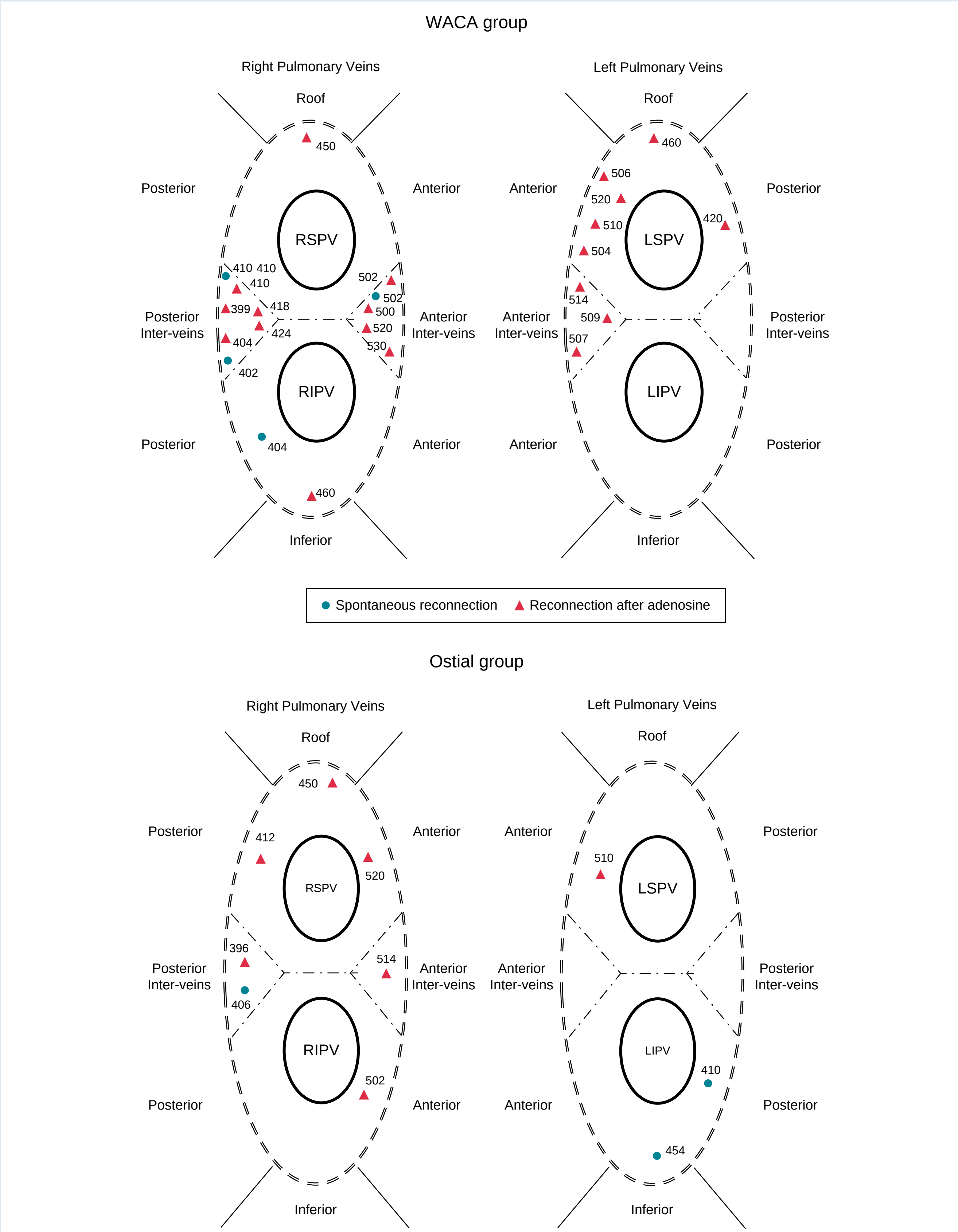


Figure 2 Diagram showing the eight-segment per PV encirclement used for analysis and the number of acute reconnections (spontaneous and provoked by adenosine) with the corresponding AI values on both groups. AI, Ablation Index; PV, pulmonary vein; LIPV, left inferior pulmonary vein; LSPV, left superior pulmonary vein; RIPV, right inferior pulmonary vein; RSPV, right superior pulmonary vein; WACA, wide-area circumferential ablation.

arrhythmia of at least 30 s duration, irrespective of symptoms, after the 3-month blanking period.[2] Safety was defined by the occurrence of any of the following events after the index AF ablation: death, major bleeding as defined by the International Society on Thrombosis and Hemostasis,[10] any thromboembolic event, atrioesophageal fistula, phrenic nerve palsy, PV stenosis, pericarditis, and vascular access complications. Phrenic nerve palsy and PV stenosis were suspected based on the presence of symptoms (as well as *de novo* pulmonary hypertension detected during follow-up) and confirmed with imaging. Procedural data including ablation and procedure times were also collected. Procedural time was defined as the time from the groin puncture to the sheath removal.

Follow-up

Patients were evaluated before hospital discharge, as well as at 3, 6, and 12 months after the index procedure. In each appointment, a 12-lead electrocardiogram and a 24 h Holter were performed. A 7-day Holter monitoring was performed once a year. No anti-arrhythmic medication was prescribed after catheter ablation (beta-blockers were allowed). The first 3 months post procedure were considered a blanking period, and recurrences in this period were not considered. In case of a documented recurrence of atrial arrhythmia during this time interval, a previously ineffective but tolerated Class I or Class III (sotalol) drug was considered. If that was the case, the patient should interrupt the AAD, 3 months after the initial procedure. The anti-coagulation strategy after the first 3 months was based on the CHA_2DS_2-VASc score.

Statistical analysis

The primary analysis was designed to test the hypothesis that ostial circumferential ablation is non-inferior to WACA in achieving acute PVI when using the AI software. Taking into consideration previous studies in which ostial PVI was guided by the AI software, we assumed an approximate 95% freedom from acute PV reconnection following PVI.[4,6,11,12] As one study reported a similar acute PV reconnection after a wide antral PVI guided by the AI,[13] then 598 PVs (150 patients, admitting 4 PVs per patient) would provide 80% power to exclude a difference of more than a non-inferiority margin of 5% at a one-sided alpha level of 0.025. The 5% non-inferiority margin was based on additional studies, in which acute PV reconnection exceeded 10% despite AI-guided ablation.[14,15] Considering that some patients could have only three PVs and/or be lost to follow-up, we increased the final study cohort by ~10%.

Categorical variables are expressed in frequencies and percentages and continuous variables are expressed as mean ± standard deviation or median and interquartile range for variables with or without normal distribution, respectively. The χ^2 test was used to assess differences between categorical variables, and the Student's *t*-test or the Wilcoxon test was used to compare continuous variables with or without normal distribution, respectively. The Kolmogorov–Smirnov test was used to test for normality of the distribution of continuous variables. Kaplan–Meier curves were performed to illustrate freedom from atrial arrhythmia during follow-up in both groups. Logistic regression was performed to assess whether the type of ablation strategy (WACA vs. ostial) is an independent predictor of acute PV reconnection (with adjustment for all predictors of acute reconnection in univariate analysis). Cox regression was used to identify any independent predictors of atrial arrhythmia recurrence during follow-up. A *P*-value <0.05 was considered statistically significant. Statistical analysis was performed using IBM SPSS Statistics version 25 (IBM, Armonk, NY, USA) software.

Results

Of the initial 169 patients enrolled in this study, 7 were lost during follow-up (Supplementary material online, *Figure S1*). The final study sample included 162 patients (64% males, mean age of 60 ± 11 years), corresponding to 605 PV—81 patients (304 PV) in the WACA group and 81 patients (301 PV) in the ostial group. The main baseline characteristics were homogenous between both groups, as detailed in *Table 1*, with no significant differences in LA dimensions, delay between first AF presentation and ablation, CHA_2DS_2-VASc score or the incidence of most comorbidities.

Procedural characteristics

A comparison between the two groups regarding procedural data is detailed in *Table 2*. Pulmonary vein isolation was achieved in all cases. There were no significant differences regarding the presence of low-voltage areas (bipolar voltage < 0.5 mV; 10% in the WACA group vs. 15% in the ostial group, $P = 0.27$) or performance of a CTI line (24% in the WACA group vs. 32% in the ostial group, $P = 0.24$).

Table 1 Baseline characteristics

	All patients (*n* = 162)	WACA group (*n* = 81)	Ostial group (*N* = 81)	*P*-value
Male gender, *n* (%)	103 (64)	52 (64)	51 (63)	0.87
Age, years (mean ± SD)	58 ± 10	58 ± 8	57 ± 12	0.71
BMI, kg/m^2 (mean ± SD)	26.8 ± 4.1	27.0 ± 4.4	26.5 ± 4.0	0.23
Hypertension, *n* (%)	86 (53)	39 (48)	47 (58)	0.21
Diabetes mellitus, *n* (%)	22 (14)	11 (14)	11 (14)	0.18
Stroke history, *n* (%)	8 (5)	5 (6)	3 (4)	0.48
Congestive heart failure, *n* (%)	9 (6)	4 (5)	5 (6)	0.72
Sleep apnoea, *n* (%)	7 (4)	2 (3)	5 (6)	0.16
Thyroid disease, *n* (%)	21 (13)	7 (9)	14 (18)	0.11
Clearance of creatinine (mL/min), mean ± SD	90 ± 25	87 ± 15	93 ± 32	0.22
CHA_2DS_2-VASc score (median, Q1–Q3)	1 (1–2)	2 (1–2)	1 (1–2)	0.12
First AF episode to PVI, months (median, Q1–Q3))	40(24–80)	48 (25–92)	38(22–73)	0.21
Previous electric cardioversion, *n* (%)	49 (32)	21 (27)	28 (37)	0.17
LVEF, % (mean ± SD)	60 ± 6	60 ± 7	61 ± 5	0.50
LA diameter (mm), (mean ± SD)	40 ± 6	40 ± 5	40 ± 6	0.64

AF, atrial fibrillation; BMI, body mass index; LA, left atrium; LVEF, left ventricle ejection fraction; PVI, pulmonary vein isolation; SD, standard deviation; WACA, wide-area circumferential ablation.

Patients in the WACA group required longer ablation (35 vs. 29 min in the ostial group, $P = 0.001$) and procedure times (121 vs. 102 min in the ostial group, $P < 0.001$; *Graphical Abstract*). There was no significant difference in the fluoroscopy time between groups (6 min in the WACA group vs. 5 min in the ostial group, $P = 0.29$).

Ablation lesion data analysis

There were no significant differences between groups in the median AI values, contact force, and force-time integral in the different LA regions (anterior, posterior, roof, and inferior; Supplementary material online, *Table S1*).

Acute reconnection

First-pass isolation occurred in 84% of WACA patients and 91% of those receiving ostial ablation ($P = 0.05$). Acute PV reconnection was less common in the ostial ablation group [3.3%, 95% confidence interval (CI) 1.8–6.1 vs. 7.9% in the WACA group, 95% CI, 4.9–11.1%; $P < 0.001$ for non-inferiority; unadjusted $P = 0.02$ for superiority; *Figure 3* and Graphical Abstract]. After adjustment to other univariate predictors of acute reconnection such as previous history of electrical cardioversion and first-pass isolation, ostial ablation halved the odds of acute PV reconnection [odds ratio 0.51 (95% CI, 0.23–0.83), $P = 0.05$; Supplementary material online, *Table S2*].

In the WACA group, 14 patients had acute reconnection of a total of 24 PVs. Spontaneous reconnection occurred in four PVs (all right PVs: two on the posterior carina, one on the anterior carina and one in the posterior segment of the inferior right PV). The remaining 20 reconnections occurred after adenosine administration (9 in the left PVs: 1 in the posterior segment of the superior left PV, 1 on the roof of the left superior PV, 4 on the anterior segment of the left superior vein and 3 on the anterior carina; 11 in the right PVs: 1 on the roof of the right superior PV, 5 in the posterior carina, 4 in the anterior carina and 1 in the inferior segment of the right inferior PV; *Figure 2* and *Table 2*).

In the ostial group, reconnection occurred in 8 patients for a total of 10 PVs. Spontaneous reconnections occurred on three PV (one in

Table 2 Procedure and follow-up data

	All patients (*n* = 162) 605 PV	WACA group (*N* = 81) 304 PV	Ostial group (*n* = 81) 301 PV	*P*-value
CTI line, *n* (%)	45 (28)	19 (24)	26 (32)	0.24
Low-voltage areas, *n* (%)	18 (12)	7 (10)	11 (15)	0.27
First-pass isolation, *n* (%)	141 (88)	68 (84)	73 (91)	0.09
Patients with acute reconnection, *n* (%)	22 (13.6)	14 (17.3)	8 (9.9)	0.05
PV acute reconnection, *n* (%)	34 (5.6)	24 (7.9)	10 (3.3)	0.05
Median PV ablation time (min)	32 (25–40)	35 (30–41)	29 (22–37)	0.001
Mean overall procedure time (min)	112 ± 33	121 ± 32	102 ± 30	<0.001
Median fluoroscopy time (min)	6 (4–8)	6 (5–8)	5 (3–8)	0.29
Arrhythmia recurrence during follow-up, *n* (%)	17 (10.5)	9 (11.1)	8 (9.9)	0.80
Complications, *n* (%)	2 (1.2)	1 (1.2)	1 (1.2)	0.99

CTI, cavotricuspid isthmus; PV, pulmonary vein; WACA, wide-area circumferential ablation.

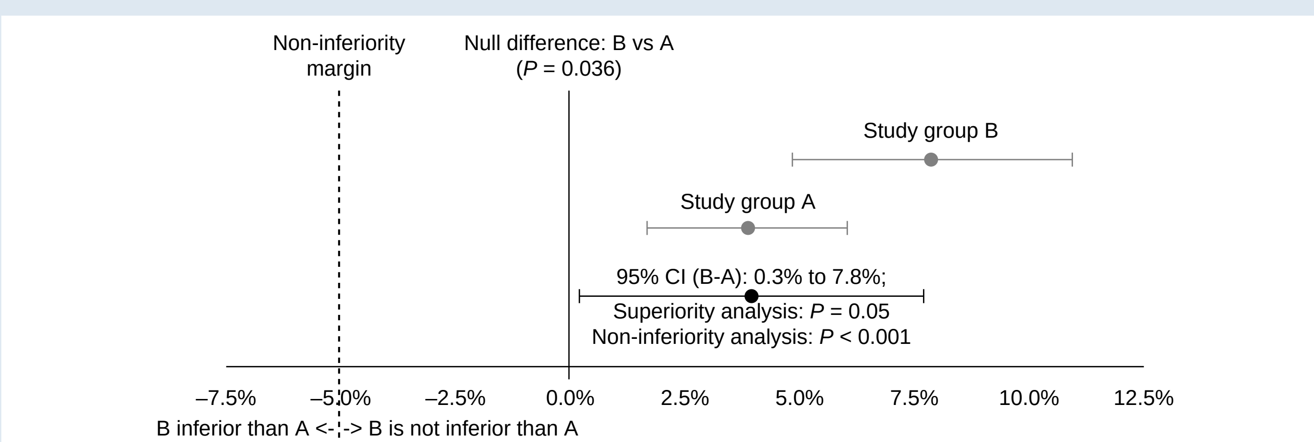


Figure 3 Diagram presenting the 95% CI for the expected difference between Groups A (ostial group) and B (WACA group) in the population (95% CI Diff) and the *P*-value for the unilateral test the superiority test. The right vertical line represents the null difference between study Groups A and B and the expected rates (95% CI) of reconnection in each study group presented in light grey. CI, confidence interval; WACA, wide-area circumferential ablation.

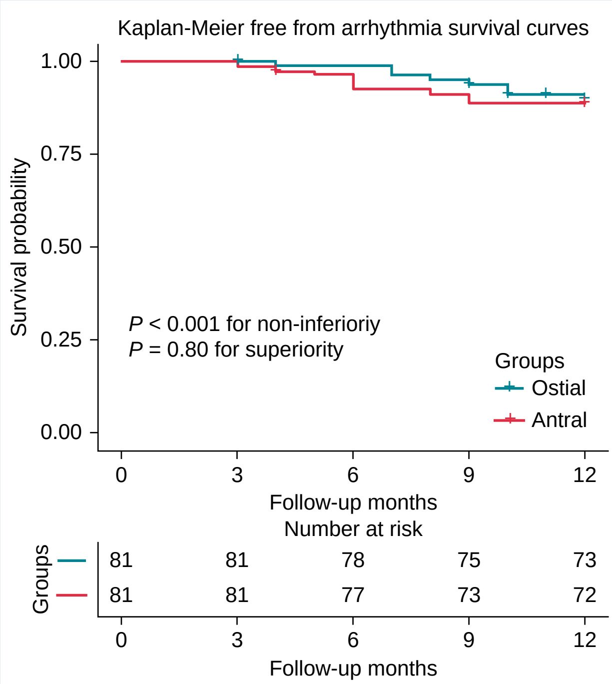


Figure 4 Freedom from recurrence of atrial arrhythmia following PVI guided by AI in the WACA group vs. the ostial group (11.1 vs. 9.9%, $P < 0.001$ for non-inferiority; $P = 0.80$ for superiority). AI, Ablation Index; PVI, pulmonary vein isolation; WACA, wide-area circumferential ablation.

the posterior carina of the right PVs, one on the posterior segment of the left inferior PV, and one on the inferior segment of the left inferior PV). The remaining seven reconnections occurred after adenosine administration (one on the anterior segment of the left superior PV, one on the roof of the right superior PV, one in the posterior segment of the right superior PV, one on the anterior segment of the right superior PV, one in the posterior carina of the right PVs, one in the anterior carina of the right PVs, and another on the anterior segment of the right inferior PV).

No acute PV reconnection occurred in the setting of a lack of contiguity between RF lesions (i.e. ILD was always ≤6 mm). The corresponding AI values at sites showing acute PV reconnections are depicted in *Figure 2*. Only 2 acute PV reconnection occurred in LA segments with AI values below the defined value in the protocol—396 and 399 in the posterior right carina, where the established target value was 400.

Follow-up and clinical outcome results

At 1-year follow-up, 17 patients had recurrences of sustained atrial arrhythmia: left atrial tachycardia in 5 patients and paroxysmal AF in the remaining 12 patients. Overall, single-procedure freedom from atrial arrhythmia after the 3-month blanking period was 89.5%, off-AAD. The risk of recurrence was similar with both ablation strategies [11.1% in the WACA group vs. 9.9% in the ostial ablation group, hazard ratio 1.13 (95% CI, 0.44–1.94), $P < 0.001$ for non-inferiority; $P = 0.80$ for superiority; *Figure 4* and Graphical Abstract]. There were no predictors of arrhythmia recurrence during follow-up, including factors such as acute PV reconnection, AF duration, and presence/absence of low-voltage areas (Supplementary material online, *Table S3*).

Two complications were reported in this study, one in each group (one femoral pseudoaneurysm in the WACA group and one pericardial effusion in the ostial group). Both cases were managed conservatively.

Discussion

To the best of our knowledge, this is the first prospective study comparing WACA and ostial circumferential ablation using the AI software. Our findings suggest that, in the setting of tailored AI-guided ablation, ostial ablation is non-inferior to WACA regarding acute PV reconnection, while allowing for shorter procedures.

Recent studies using the AI software have shown lower acute PV reconnection when employing ostial circumferential ablation with a figure of eight around PVs.[4,6] Likewise, our results suggested similarly low acute PV reconnection when an ostial PVI strategy was employed. However, when performing WACA, a lower first-pass isolation was observed with a higher rate of acute PV reconnection, similar to that reported by Hussein *et al.*,[13] who also employed antral PVI. Two possible explanations may explain our findings. First, given that tissue thickness increases when farther from the PVs, it is possible that the established AI values may not apply as well when performing ablation outside the ostia of the PVs.[16] As recently reported, left atrial wall thickness varies substantially in posterior and anterior walls.[17,18] Second, it is plausible that a wider lesion set that does not cover the carina may result in residual conduction through epicardial connections. Recently, Cabrera *et al.*[19] showed histological evidence of the intermuscular connections between contiguous PV orifices where fascicles meet and are interwoven. Indeed, in our study, the majority of the acute reconnections were located in two main places: in the carina of the right PVs and the anterior segment/carina of the left superior PV. Both places are known for their epicardial connections, mainly from the right veins to the right atrium and from the left PV with the LA across the ligament of Marshall,[9,20–22] and are also characterized by their increased wall thickness.[17,18] A previous study suggested that a distance >8 mm between ablation lesions and the PV ostia predicted incomplete PVI and would require additional carina ablation, potentially increasing the risk of PV stenosis.[23] Even when 50 W was delivered, we reported no severe RF-related adverse events, such as deaths, strokes, atrioesophageal fistulas, or cases of symptomatic PV stenosis, similar to the findings reported in previous studies where AF ablation was guided by the AI.[7,24,25]

The main objective when performing PVI is to obtain high freedom from arrhythmia recurrence or at least a significant decrease in AF burden. Taking this into consideration, several factors may support the potential advantage of a wide antral PVI, such as the elimination of re-entry wavelets located around the PVs, autonomic denervation, debulking of the LA and ablation of non-foci located in the posterior wall.[26] A previous meta-analysis comparing WACA vs. ostial ablation showed some superiority to a wide antral strategy.[26] However, this study included persistent AF patients and was performed before the widespread adoption of contact-force-sensing technology. Thus, the rates of acute and long-term recurrence were higher compared with those obtained nowadays with the use of the AI software.[4,6,7,15,24] Our results are aligned with those obtained by Lin *et al.*[23] without the AI, who reported no significant differences in long-term outcome between the two strategies despite an increased rate of acute PV reconnection in the antral group. Our findings suggest that wide antral ablation may be unnecessary when performing AI-guided paroxysmal AF ablation, prolonging the procedure without improving freedom from arrhythmia recurrence. Longer ablation and procedure times may increase the risk of complications and reduce the turnover in the electrophysiology laboratory.[27] We highlight, however, that these results should not be extrapolated to persistent

AF, in which case further studies are necessary to assess whether AI-guided WACA can still be beneficial.

In summary, when performing AI-guided ablation of paroxysmal AF, ostial circumferential ablation is not inferior to WACA with lower rates of acute PV reconnection, while allowing for shorter procedures.

Limitation

We acknowledge some limitations in our work. First, this study was not randomized and thus a selection bias should be considered as likely. However, potential confounders were mitigated by the prospective multicentre design with consecutively included patients with similar baseline characteristics (including LA size, delay between first AF episode and ablation and presence of low-voltage areas). Moreover, procedures were performed by operators with a similar degree of experience and guided by the same AI targets, as shown by the absence of significant differences between groups in contact force, force-time integral and AI values in the different LA segments. Second, we acknowledge that a waiting period might have resulted in more frequent acute reconnections. However, as previously shown by our group, a 20 min waiting period does not seem necessary when performing AI-guided PVI.[6] Third, this study was not powered to allow definite conclusions regarding long-term effectiveness. It is still possible that some subgroups of patients (e.g. those with larger left atria) may benefit from WACA to allow substrate modification in addition to PVI. Nevertheless, the study size was comparable with other similar studies that assessed these strategies in the pre-AI era,[28,29] and our study provides the first comparison between ostial and antral PVI guided by the same AI target value. Randomized, large-scale studies are required to confirm our results and assess their clinical implications. Fourth, the use of an implantable loop recorder would have documented a higher rate of asymptomatic atrial arrhythmia. However, as monitoring was identical in both groups, this limitation had no expected impact on our main findings. Fifth, both groups had circumferential PVI (either ostial or WACA), which is associated with significantly less PV stenosis.[30,31] However, it is well recognized that RF ablation closer to the PV ostia or within the PVs may increase the rate of PV stenosis.[2] Our patients did not have systematic imaging to exclude PV stenosis and we cannot exclude any cases of asymptomatic PV stenosis. However, no patient had *de novo* pulmonary hypertension on routine transthoracic echocardiography. Given the low incidence of clinically apparent PV stenosis with circumferential PVI, larger studies are required to confirm these results. Sixth, although, PV ostium and WACA were clearly defined, we recognize that a small degree of overlap between these two strategies cannot be excluded.

Conclusions

In paroxysmal AF patients treated with tailored PVI guided by the AI, ostial circumferential ablation is not inferior to WACA, while allowing for shorter procedures.

Supplementary material

Supplementary material is available at *Europace* online.

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Data availability

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

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