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CLINICAL RESEARCH

Acute durability of cavotricuspid isthmus block after pulsed electric field ablation: randomized comparison of two pentaspline catheter configurations (SECTION trial)

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Aims

Cavotricuspid isthmus (CTI) ablation is commonly performed alongside catheter ablation of atrial fibrillation (AF). However, the acute efficacy of the CTI ablation using the pentaspline catheter and pulsed electric field (PEF) energy has not been systematically evaluated. This randomized study assessed the acute efficacy and extent of haemolysis associated with CTI ablation when performed using two different configurations of the pentaspline catheter.

Methods and results

A total of 178 patients (age 65 ± 10 years, 66% of males) undergoing PEF ablation of the CTI in conjunction with AF ablation were randomly assigned to receive ablation using either the basket configuration ($n = 95$) or the flower configuration ($n = 83$) of the pentaspline catheter. The CTI ablation was performed before left atrial ablation. It was guided by intracardiac echocardiography, and bidirectional block was confirmed by pacing manoeuvres. Venous blood samples to assess haemolytic biomarkers were collected before and immediately after the CTI ablation. The groups were broadly comparable in baseline characteristics. The flower group demonstrated superior procedural efficiency, with fewer applications required to achieve a CTI block (3.4 ± 3.1 vs. 8.0 ± 4.1, $P < 0.001$), a shorter time to block (96 ± 289 vs. 177 ± 192 s, $P < 0.001$), and fewer total applications (10.1 ± 3.4 vs. 13.3 ± 5.1, $P < 0.001$). Acute reconduction occurred in 20% of cases overall, but was significantly lower in the flower group (6% vs. 32%, $P < 0.001$; hazard ratio: 0.14, 95% confidence interval: 0.06–0.40). Haemolysis was notably lower in the flower group, with significantly less post-procedural free haemoglobin (154 ± 112 vs. 210 ± 115 mg/L, $P < 0.001$). One case of transient ST elevations occurred in the flower group without clinical consequence.

Conclusion

Pulsed electric field ablation of the CTI using the flower configuration of the pentaspline catheter demonstrated higher acute efficacy in achieving CTI block and a more favourable safety profile regarding haemolysis compared to the basket configuration. This is likely due to the larger footprint and improved tissue contact of all electrodes, minimizing the leakage of PEF energy into the blood pool.

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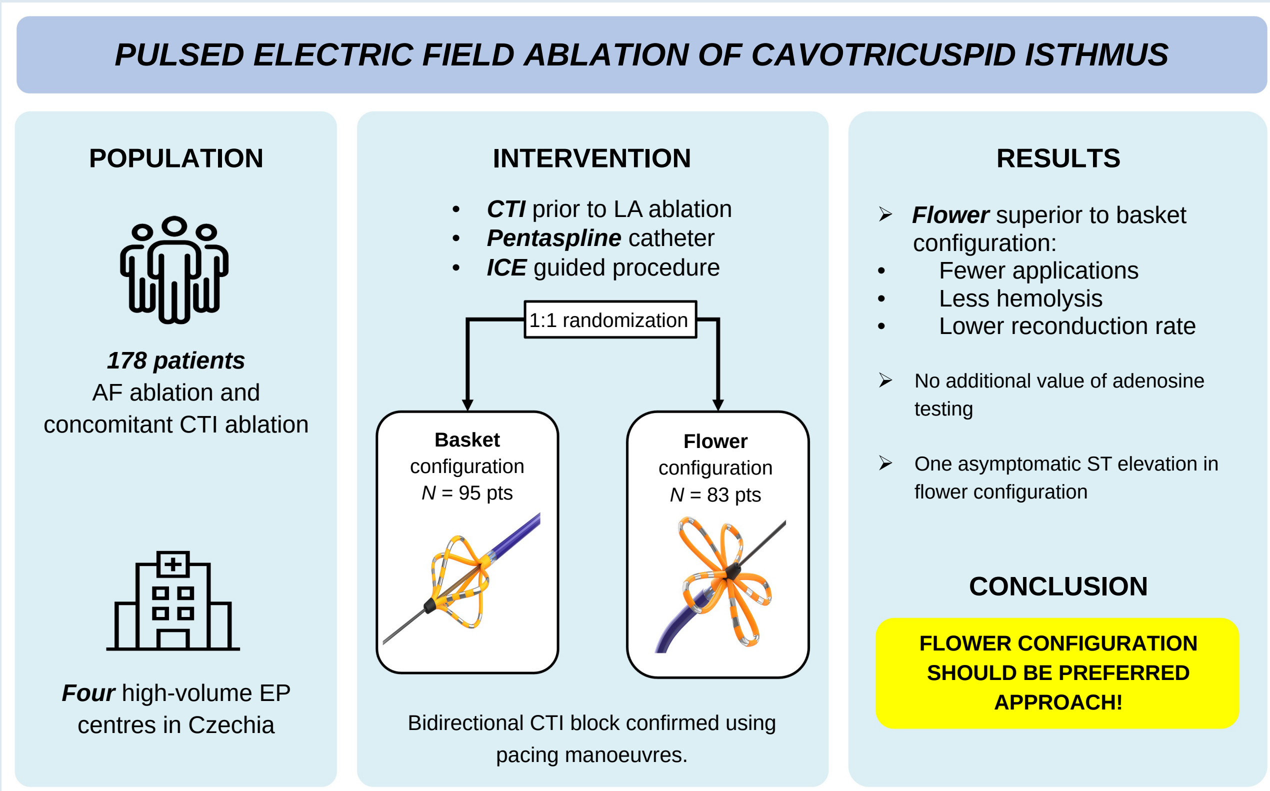
Graphical Abstract



Keywords Catheter ablation • Atrial flutter • Pulsed electric field

What's new?

1. Pulsed electric field ablation using the pentaspline catheter is a safe, fast, and effective method for cavotricuspid isthmus (CTI) ablation.
2. The flower configuration exhibited superior performance, requiring fewer applications, which resulted in less haemolysis and lower acute reconduction rates.
3. Most acute reconductions occurred within the first 30 min of the waiting period.
4. Adenosine testing for dormant conduction on CTI did not provide any additional value.

Introduction

Catheter ablation is a well-established treatment strategy for rhythm control in symptomatic patients with atrial fibrillation (AF), with pulmonary vein (PV) isolation (PVI) being the cornerstone of the ablation procedure.[1-3] In addition to PVI, cavotricuspid isthmus (CTI) ablation is often performed as a concomitant procedure, especially in patients with documented or inducible typical atrial flutter or as part of a more extensive ablation strategy.[4]

Traditionally, CTI ablation has utilized radiofrequency (RF) energy, demonstrating excellent acute success rates and long-term durability.[5,6] However, the introduction of pulsed electric field (PEF) ablation as a non-thermal and tissue-selective modality has emerged as a promising alternative to conventional energy sources.[7–11]. Despite the increasing interest in PEF ablation, its application to CTI ablation is still relatively new, and data regarding the acute durability of CTI block achieved with PEF energy are currently limited.

This study aimed to systematically evaluate the acute durability of the CTI block when ablation was performed using PEF energy. We specifically compared two configurations, the basket and flower, of the pentaspline catheter (Farawave, Boston Scientific Inc.). We focused on their relative efficacy in achieving acute CTI block and their association with procedure-related adverse events, such as haemolysis and coronary vasospasm.

Additionally, the study investigated the incidence and timing of reconduction on CTI during the procedural waiting period, allowing us to identify the optimal waiting time for assessing acute lesion durability. We also examined the role of adenosine administration in unmasking dormant conduction, which may provide insight into the necessity of routine adenosine testing in this context.

Methods

Study population and study design

A multicentre, randomized study was conducted at four high-volume centres in Czechia with the routine use of intracardiac echocardiography (ICE). Patients with symptomatic AF scheduled for ablation by PEF energy were eligible if they had either (i) paroxysmal AF and documented typical atrial flutter or (ii) persistent AF with planned CTI ablation as a part of a complex procedure. Exclusion criteria were a left atrial (LA) diameter of >65 mm (measured in the parasternal long-axis view), a history of CTI ablation, a history of cardiac valve surgery, significant valvular disease, and an age of <18 years. Simple randomization was used to allocate the patients into two groups in a 1:1 fashion, with basket or flower catheter configurations used to create the CTI block.

Ethical committee approval

The protocol has been approved by the Ethics Committee of the Institute for Clinical and Experimental Medicine and Thomayer Hospital in Prague, reg. number 28518/24; A-24-24. The trial was registered in the ClinicalTrials.gov Registry, reg. number NCT06691074 (accessible at clinicaltrials.gov). All patients provided written informed consent before the procedure.

Catheter ablation procedure

Procedures were performed under general anaesthesia or deep analgosedation, using propofol and fentanyl, with uninterrupted anticoagulation. After obtaining vascular access, heparin was administered to maintain an activated clotting time level of 350 s. A decapolar catheter was introduced into the coronary sinus (CS), while a duodecapolar catheter was placed in the right atrium around the tricuspid annulus. A single transseptal puncture was performed under the ICE guidance (AcuNav, Siemens). After obtaining the LA access, the 31 mm pentaspline ablation catheter was pulled back into the right atrium. Patients presenting with AF or other atrial arrhythmias at the beginning of the procedure were cardioverted.

Before initiating PEF ablation on the CTI, sublingual nitrates were administered as two nitroglycerin sprays, each at 0.3 mg. Nitroglycerin was not administered to patients with hypotension (systolic blood pressure < 90 mmHg). The CTI ablation was performed during regular atrial pacing from the proximal CS at a cycle length of 600 ms. Sequential applications of PEF energy were delivered in an overlapping manner (at least one-half of the catheter dimension) from the tricuspid annulus to the inferior cava vein under ICE guidance with careful monitoring of catheter-tissue contact. Three applications were deployed at a single site, each consisting of a train of five packets of pulses over 2.5 s. During basket ablation at the CTI, the terminal J-shaped portion of the wire remained outside the catheter. The fluoroscopic and corresponding ICE images of the pentaspline catheter positioned at the CTI are depicted in *Figure 1* in both basket and flower configurations. If an acute block could not be achieved using the study-allocated catheter configuration, the operators were allowed to employ an alternative configuration at their discretion to achieve the acute block. After demonstrating a bidirectional CTI block with standard pacing manoeuvres (differential pacing from the low lateral right atrium and proximal CS), the surface electrocardiogram was analysed across all 12 leads to check for any ST-segment elevation.

The LA procedure was then conducted during regular atrial pacing from the proximal CS. Any recovery of conduction over the CTI and the corresponding time since the last ablation on the CTI were recorded. Dormant conduction over the CTI was assessed using an intravenous bolus of adenosine (12 mg, or 18 mg in patients weighing over 100 kg) during continuous atrial pacing immediately after finishing the CTI lesion. This testing was repeated at the end of the procedure. If necessary, additional PEF applications were delivered on the CTI at the operator's discretion.

The total waiting time and the number of PEF applications on the CTI were documented. The waiting time for CTI block durability was not prespecified, as the duration of the LA procedure in the meantime ensured a reasonable time for CTI reconnection. In addition, the time taken for the LA procedure using the Farapulse system is highly predictable, so no difference in waiting time between groups was expected.

Pulsed electric field ablation in the left atrium

After the CTI ablation, the LA was accessed through a pre-punctured hole in the septum. Pulmonary vein isolation was performed with a pentaspline catheter under ICE guidance. The catheter was positioned sequentially at the ostia of each PV, with eight applications used per vein, with four in a basket configuration and four in a flower configuration. Additional applications at the PV ostia or antra were used as needed. Pulmonary vein isolation was confirmed by pacing and sensing from the PVs, demonstrating the exit and entry block. Ablation beyond PVI, including posterior wall, anterior wall, or lateral mitral isthmus, was performed at the operator's discretion based on the extent of LA disease, and spontaneous initiation or inducibility of AF/atrial tachycardia. The catheter was used in the flower or basket configuration to ensure a broad, overlapping lesion set.

Plasmatic biomarkers

Venous blood samples were collected to assess plasma biomarkers of haemolysis [free haemoglobin (fHb), lactate dehydrogenase (LDH), and

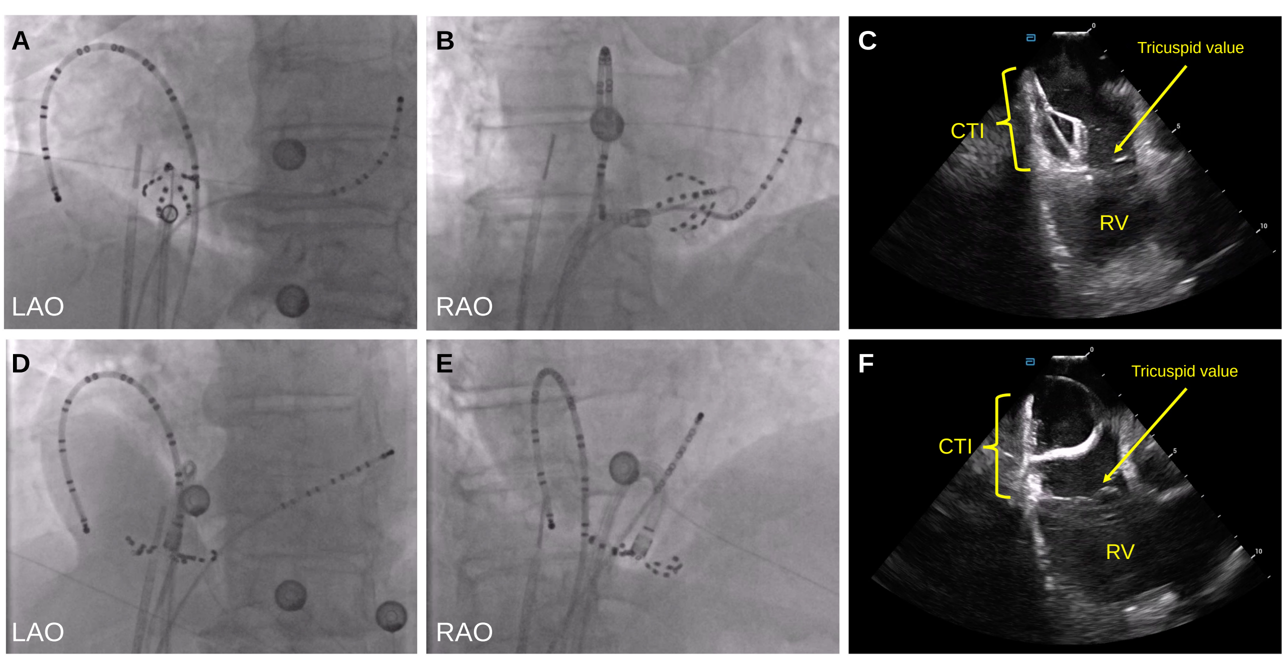


Figure 1 Position of the pentaspline catheter at the CTI. The pentaspline catheter is shown in basket configuration in LAO and RAO view (A and *B*) and in flower configuration (*D* and *E*) with corresponding examples of ICE imaging (C and *F*). Corresponding video files (mp4) are available in the Supplementary material. CTI, cavotricuspid isthmus; RV, right ventricle.

Table 1 Baseline characteristics

	All $N = 178$	Basket group $N = 95$	Flower group $N = 83$
Females	61 (34%)	25 (26%)	36 (43%)
Age (years)	65 (10)	65 (10)	66 (10)
BMI (kg/m^2)	30.3 (5.2)	30.2 (5.3)	30.4 (5.1)
AF history (months)	40 (43)	36 (38)	44 (48)
History of typical flutter	38 (21%)	21 (22%)	17 (20%)
Previous AF ablation	21 (12%)	14 (15%)	7 (8.4%)
Arterial hypertension	121 (68%)	70 (74%)	51 (61%)
Diabetes	34 (19%)	13 (14%)	21 (25%)
Coronary artery disease	17 (9.6%)	12 (13%)	5 (6.0%)
eGFR < 60 mL/min (CKD-EPI)	19 (11%)	11 (12%)	8 (9.6%)
CHA_2DS_2-VASc	2.57 (1.59)	2.43 (1.60)	2.73 (1.58)
Echocardiography			
LVEF (%)	56 (11)	55 (11)	56 (12)
LAVi (mL/m^2)	46 (16)	46 (15)	46 (17)
LAd (mm)	45 (7)	45 (7)	46 (7)
TAPSE (mm)	22.0 (5.2)	22.5 (4.6)	21.5 (5.9)
S' (cm/s)	11.4 (4.8)	11.5 (5.1)	11.2 (4.3)
RA area (cm^2)	21 (6)	22 (6)	21 (6)
RV d1 (mm)	39.0 (5.7)	39.3 (6.6)	38.5 (4.4)
Rhythm on admission			
Sinus rhythm	127 (71%)	68 (72%)	59 (71%)
AF	42 (24%)	24 (25%)	18 (22%)
Typical flutter	5 (2.8%)	2 (2.1%)	3 (3.6%)
Atrial tachycardia	4 (2.2%)	1 (1.1%)	3 (3.6%)

Values are mean (standard deviation) or count (%).
AF, atrial fibrillation; BMI, body mass index; CKD-EPI, Chronic Kidney Disease Epidemiology Collaboration; eGFR, estimated glomerular filtration rate; LAd, left atrial diameter, LAVi, left atrial volume index; LVEF, left ventricular ejection fraction; RA, right atrium; RVd1, right ventricle diameter; TAPSE, tricuspid annulus systolic excursion.

total bilirubin]. Samples were taken at two time points: before the procedure and after CTI isolation and before LA ablation.

Statistical analysis

While no pilot data were available for comparing different Farawave configurations on CTI, we estimated a reconnection-free rate of 80% in the basket configuration based on our clinical experience. For flower configuration, we expected an improvement of the reconnection-free rate to 95%. Such a hypothesis can be tested with a two-sided alpha of 0.05 and a power of 0.80 in a study with 76 patients in each of two arms.

All statistical analyses, based on the intention-to-treat principle, were conducted using R (The R Foundation for Statistical Computing, Vienna, Austria). Continuous variables are presented as means ± standard deviations or medians with interquartile range (IQR). Categorical variables are displayed as counts with percentages. Groups were compared using the Mann–Whitney U test, Pearson's χ^2, and Fisher's exact test as appropriate. Kaplan–Meier plots with the log-rank test and a Cox proportional hazards regression model were used to compare the risk of acute CTI reconduction in randomized study groups, as well as in subgroups according to gender. Time to reconduction was used as the time-to-event variable, and hazard ratios with 95% confidence intervals were estimated for each analysis. The Cox model was also used to explore the interaction between gender and the randomization group, testing for effect modification. A $P < 0.05$ was considered significant throughout the study.

Results

Between September 2024 and May 2025, 178 patients were enrolled, and all completed the study protocol. A total of 95 patients underwent CTI ablation using the basket configuration, while 83 patients were treated with the flower configuration. Baseline characteristics listed in *Table 1* were broadly comparable between the two groups, although the flower group had a higher proportion of female patients (43% vs. 26%, $P = 0.02$) and a greater prevalence of diabetes (25% vs. 14%, $P = 0.049$). Other demographic and echocardiographic parameters, including age, CHA_2DS_2-VASc score, LA volume index, and ejection fraction, showed no significant differences between groups.

Procedural data are provided in *Table 2*. In terms of procedural efficiency, the flower group was superior to the basket group, requiring fewer applications to achieve conduction block (3.4 ± 3.1 vs. 8.0 ± 4.1, $P < 0.001$), shorter time to CTI block (96 ± 289 vs. 177 ± 192 s, $P < 0.001$), and fewer total applications (10.1 ± 3.4 vs. 13.3 ± 5.1, $P < 0.001$). Cross-over occurred in two patients (both from the basket group) due to an inability to achieve the CTI block with the allocated catheter configuration. The CTI anatomy, including isthmus length and the presence of a pouch, was comparable between both groups. Furthermore, other procedural metrics, such as fluoroscopy time and total PEF pulses, were similar for both groups.

Table 2 Procedural characteristics

	All $N = 178$	Basket group $N = 95$	Flower group $N = 83$	P-value
Hospital stay (days)	2.57 (1.99)	2.51 (1.73)	2.64 (2.27)	0.6
Procedural skin-to-skin time (min)	82 (27)	82 (27)	81 (28)	0.7
Fluoroscopy time (min)	11.3 (4.9)	10.8 (5.0)	11.9 (4.9)	0.2
Number of applications until the CTI block	5.9 (4.3)	8.0 (4.1)	3.4 (3.1)	***<0.001***
Time to CTI block (min)	2.3 (4.1)	2.9 (3.2)	1.6 (4.9)	***<0.001***
Reconduction	35 (20%)	30 (32%)	5 (6.0%)	***<0.001***
Time to CTI reconduction (min)	18 (18)	15 (16)	33 (20)	0.10
Waiting time for CTI reconduction (min)[a]	45 (18)	44 (17)	46 (19)	0.9
CTI length (mm)	37 (9)	36 (10)	37 (9)	0.5
Pouch on CTI	14 (7.9%)	9 (9.5%)	5 (6.0%)	0.4
Total number of CTI applications	11.8 (4.7)	13.3 (5.1)	10.1 (3.4)	***<0.001***
Total number of applications	75 (18)	77 (18)	72 (18)	***0.05***
AADs at discharge				0.8
No AADs	88 (49%)	45 (47%)	43 (52%)	
Ic AADs	47 (26%)	26 (27%)	21 (25%)	
Amiodarone	43 (24%)	24(25%)	19 (23%)	
Posterior wall ablation	133 (75%)	70 (74%)	63 (77%)	0.6
Anterior wall ablation	65 (37%)	34 (36%)	31(38%)	0.8
Mitral isthmus ablation	15 (8.4%)	9 (9.5%)	6 (7.2%)	0.6

Values are mean (standard deviation) or count (%). Bold/italicized font indicate the significant *P*-values (<0.05).
AADs, antiarrhythmic drugs; CTI, cavotricuspid isthmus.
[a]Assessed in patients without reconduction.

Acute reconductions at the CTI occurred in 35 of 178 (20%) patients. Most reconduction events on the CTI occurred during the first 30 min (*Figure 2A*), with nearly 50% of reconductions within the first 10 min of waiting time (*Figure 2B*).

The median waiting time was virtually identical in the flower and basket groups: 44 (IQR: 33–56) minutes and 43 (IQR: 33–55) minutes, respectively. Cavotricuspid isthmus reconductions were significantly less frequent in the flower group compared to the basket group [5/83 (6%) vs. 30/95 (32%), HR: 0.15, 95% CI: 0.06–0.40, $P < 0.001$]. Kaplan–Meier survival curves illustrating freedom from CTI reconduction during the waiting time are shown in *Figure 3*. In patients with reconduction, the median time to CTI reconduction was 9 (IQR: 5–21) minutes in the basket group and 34 (IQR: 33–45) minutes in the flower group, respectively. Notably, adenosine administration conducted early after CTI ablation and at the end of the procedure did not reveal dormant conduction across the CTI in any patient.

Cox regression analysis showed that the flower configuration compared to the basket configuration had a reduced risk of CTI reconduction, consistent across both genders (P for interaction $= 0.29$), and gender had no independent effect on reconduction (adjusted $P = 0.6$).

Adjunctive ablation beyond PVI was performed with comparable extent in study groups: posterior wall ablation (77% flower vs. 74% basket, $P = 0.6$), anterior wall ablation (38% vs. 36%, $P = 0.8$), and mitral isthmus ablation (7.2% vs. 9.5%, $P = 0.6$). At the time of discharge, approximately half of the patients in both groups used antiarrhythmic drugs.

Regarding haemolysis (*Table 3*), the basket group showed significantly higher levels of free haemoglobin after CTI ablation (210 ± 115 vs. 154 ± 112 mg/L, $P < 0.001$) and a greater absolute increase in free haemoglobin (113 ± 107 vs. 76 ± 106 mg/L, $P = 0.002$). Lactate dehydrogenase, bilirubin, and creatinine levels were comparable between the groups. Increments of free haemoglobin per application were only non-significantly higher (by 32%) in the basket vs. the flower group (9.6 vs. 7.3 mg/L). Changes in haemolytic markers during the periprocedural period are displayed in *Figure 4*. Transient ST elevations were observed only in one patient from the flower group who did not receive prophylactic nitroglycerin due to baseline hypotension. This event did not require further treatment or investigation, and it did not prolong the hospital stay. No other major clinical complications occurred.

Discussion

To the best of our knowledge, this is the first study to systematically evaluate the safety and efficacy of PEF ablation of the CTI using the pentaspline catheter in both flower and basket configurations. Pulsed electric field ablation was a highly effective and safe method for CTI ablation, with reasonable acute durability of conduction block across the CTI. These results suggest that PEF is a viable alternative to traditional thermal ablation techniques for treating CTI-dependent atrial flutter, especially when CTI ablation is performed concomitantly with the ablation of AF.

One of the key contributions of our study is the comparative analysis of two catheter configurations: the flower configuration and the basket configuration. The flower configuration consistently outperformed the basket configuration across several parameters. Specifically, it achieved CTI block with fewer applications, demonstrated reduced haemolysis, and showed a lower acute reconduction rate in both male and female patient subgroups. These findings suggest that the flower configuration may facilitate more effective and homogeneous lesion formation in the CTI region due to more expansive and conformal tissue contact.

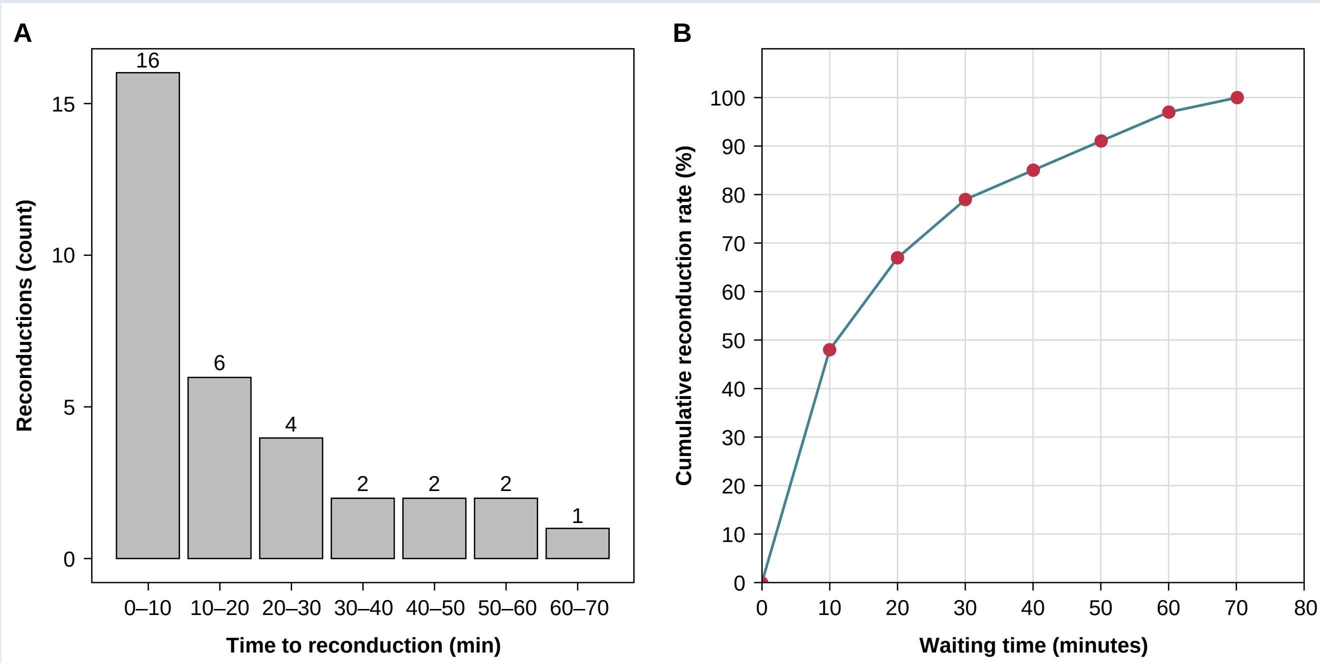


Figure 2 Temporal distribution and cumulative CTI reconduction rates during the waiting period. A graph shows a decline in reconduction rates during the waiting period. Half of them occurred during the first 10 min (*A*). Note that during a waiting period of 10 and 30 min, ∼50% and 80% of acute CTI reconductions were detected, respectively. Longer waiting times and potential re-ablation may enhance the long-term durability of the CTI block (*B*).

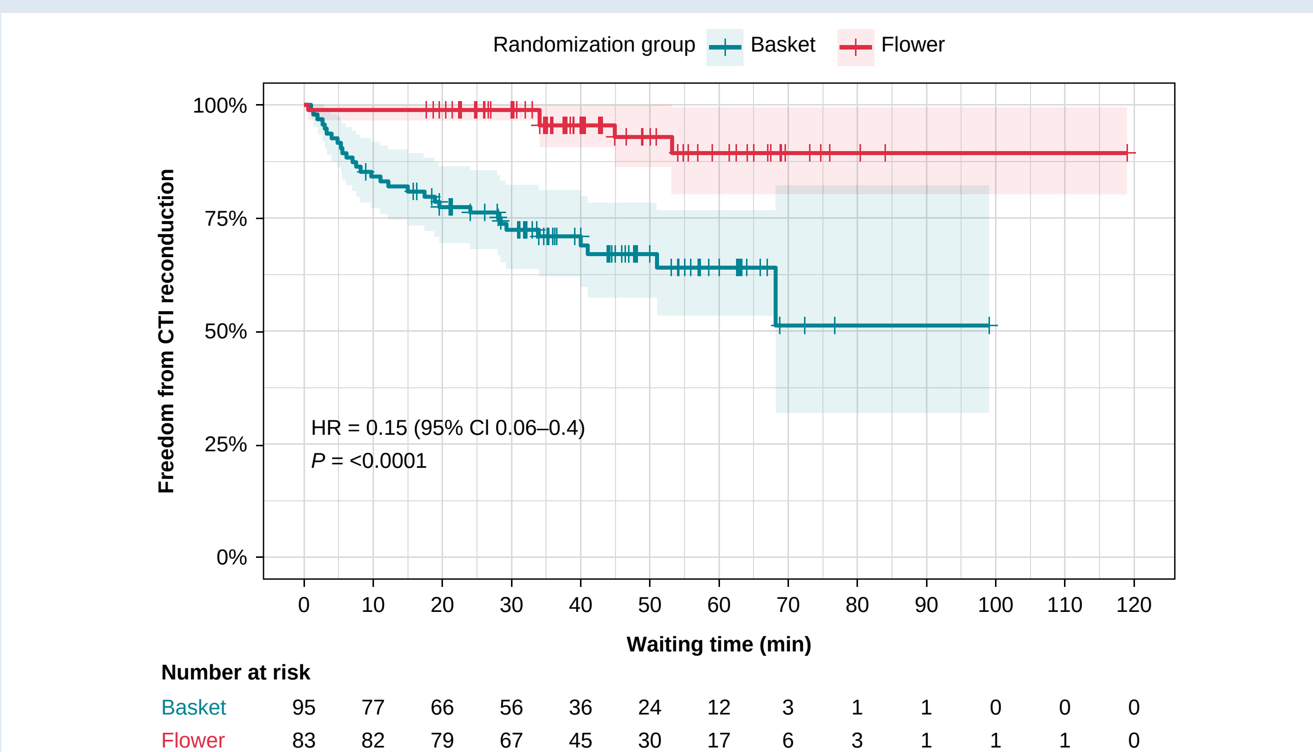


Figure 3 Freedom from CTI reconduction during the waiting time. Kaplan–Meier survival curves illustrating freedom from CTI reconduction during the waiting time dichotomized by catheter configuration (basket vs. flower). *P*-values are for long-rank test.

Table 3 Haemolytic markers at baseline and after the CTI ablation

	All N = 178	Basket group N = 95	Flower group N = 83	*P*-value
Free Hb baseline (mg/L)	72 (63)	73 (63)	71 (63)	0.9
Free Hb after ablation (mg/L)	182 (117)	210 (115)	154 (112)	***<0.001***
Free Hb difference (mg/L)	96 (108)	113 (107)	76 (106)	***0.002***
Free Hb difference per application (mg/L)	8.6 (9.5)	9.6 (10.2)	7.3 (8.7)	0.10
LDH baseline (μkat/L)	3.16 (0.80)	3.13 (0.70)	3.20 (0.91)	0.8
LDH after ablation (μkat/L)	3.29 (0.80)	3.28 (0.62)	3.31 (0.96)	0.5
Bilirubin baseline (μmol/L)	16 (8)	16 (7)	16 (8)	0.5
Bilirubin after ablation (μmol/L)	17 (8)	17 (7)	16 (9)	0.4

Values are means (SD). Bold/italicized font indicate the significant *P*-values (<0.05).
Hb, haemoglobin; LDH, lactate dehydrogenase.

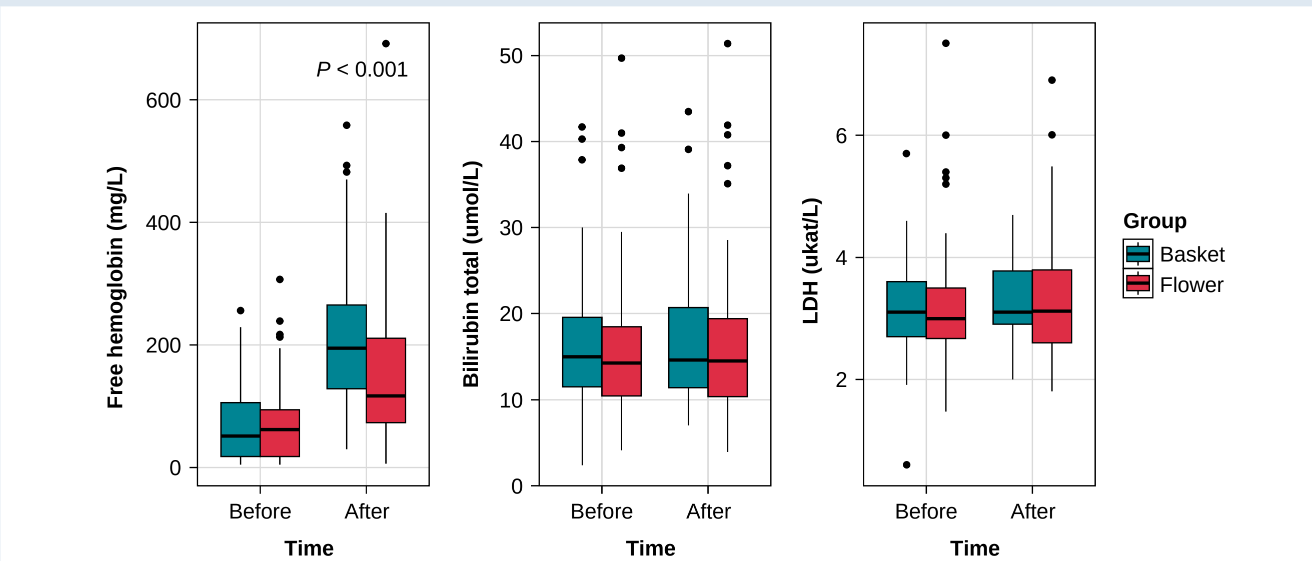


Figure 4 Haemolytic markers. Procedural (CTI ablation-related) changes in plasma biomarkers of haemolysis, categorized by study groups.

Our data provide valuable insights into the optimal strategy for CTI ablation using PEF. We found that most acute reconduction events occurred within the first 30 min after the initial ablation. This observation aligns with previous studies that have utilized RF energy.[12,13] Importantly, if the waiting time were limited to just 10 min, approximately half of these reconduction cases would have been missed, which may compromise the long-term success of the procedure. This highlights the necessity of a sufficient waiting period, ideally 20–30 min after CTI ablation, to confirm a durable block. Additionally, performing CTI ablation at the beginning of the procedure proved practical and efficient, as it allowed for adequate waiting time without increasing the total procedure duration. The utility of a waiting period to detect residual connections after PEF PVI has been demonstrated in another study.[14]

Adenosine testing has been extensively employed after PVI or CTI ablation using RF energy to unmask dormant conduction.[15,16] This technique enhances the durability of lesion sets by identifying transient reconductions, thereby reducing waiting time and allowing for additional ablation during the index procedure.[17] However, in the context of PEF of CTI, our observations showed no evidence of reconduction following adenosine administration. This suggests that the non-thermal mechanism of PEF may differ from the RF lesion formation mechanism. Based on these findings, we propose that adenosine should not be routinely used following CTI ablation with PEF, and its role in this context should be re-evaluated.

Our results should be considered in light of the fact that we routinely use ICE in AF ablation procedures. Intracardiac echocardiography plays a crucial role in providing real-time visualization of the catheter-tissue interface, making it a significant contributor to the success and safety of the procedure.[18,19] It allowed us to confirm the appropriate contact of the pentaspline catheter with the CTI, especially in the area behind the Eustachian ridge, as well as the accurate positioning of the catheter to create overlapping lesions. In addition, ICE imaging can prevent excessive prolapse of the splines into the tricuspid valve annulus, which could lead to suboptimal lesion formation or increase the risk of valvular or ventricular complications. Therefore, our study likely provided the lowest estimate of CTI reconduction rates for centres that are not using ICE navigation.

From a safety perspective, the low incidence of adverse events reinforces the favourable safety profile of PEF in CTI ablation. Only one case of transient ST elevations, probably due to coronary artery spasm, was observed in a patient in the flower group who had not been pretreated with nitroglycerin due to baseline hypotension.

A study by Nies *et al.*[20] demonstrated that haemolysis associated with *in vitro* PEF ablation is both dose- and contact-dependent. They found that the absence of catheter contact resulted in a threefold increase in free haemoglobin levels. In contrast, our findings indicate that the significantly higher haemolysis observed in the basket vs. flower group is primarily due to the greater number of applications required rather than differences in catheter-tissue contact. This is supported by a non-significantly higher increment of free haemoglobin per application in the basket vs. the flower group. The absence of a difference comparable to that in the experimental study remains speculative. In part, this can be explained by the presence of non-zero contact (at least two splines) in the case of a basket configuration and occasional suboptimum contact of the catheter in a flower configuration. None of the study patients experienced severe acute kidney injury (AKI) after the procedure. This observation is consistent with previous studies, which have shown that AKI after PEF ablation is a relatively rare event.[21]

Overall, the results from this study indicate that, although the pentaspline catheter was primarily designed for PVI, its acute efficacy and safety profile in flower configuration also support its use for CTI ablation to prevent the typical flutter in selected patients undergoing PEF ablation of AF.

Study limitations

This study has several limitations. Coronary angiography was not performed during the ablation procedures, which means that minor or asymptomatic coronary artery spasms may have been missed. We also did not systematically collect data on nitroglycerin premedication. Not providing this treatment to hypotensive patients as per the study protocol may not be an optimal strategy. We did not assess the clinical outcomes of patients as the randomized study protocol was followed only until the moment of establishing the first CTI block. Any further CTI and LA ablations were at the discretion of the operator, and the subsequent clinical endpoints primarily included recurrent AF and non-CTI-dependent atrial tachycardias. We did not use a dedicated 3D mapping system as it was not commercially available at the time of the study. The slight imbalance in group sizes resulted from simple randomization without stratification or blocking. Although baseline characteristics in both study groups were broadly comparable, we cannot completely rule out the possibility that minor differences may have affected the results. Additionally, randomization was not stratified by operator or centre, which may have introduced variability in procedural technique and outcomes. No screening log was maintained; therefore, data on non-eligible patients are unavailable, which limits the assessment of the study's external validity. From a technical perspective, recrossing the interatrial septum via a pre-punctured transseptal hole without leaving a wire in the LA may be challenging, particularly in centres without experience with ICE. The PR intervals before and after ablation were not systematically assessed. However, no cases of even first-degree atrioventricular block were reported as complications of the procedure. Importantly, the findings of this study may not be generalizable to other PEF catheter platforms, as procedural characteristics, energy delivery parameters, and catheter design may differ between systems. Finally, we were unable to evaluate the impact of both ablation strategies on the extent of myocardial necrosis because the early troponin level is not representative, while the delayed level is predominantly influenced by the extent of LA ablation.

Conclusion

Cavotricuspid isthmus ablation using PEF energy with the flower configuration of the pentaspline catheter has been found to be effective and safe in patients who have been pretreated with nitroglycerin. The flower configuration outperformed the basket configuration by requiring fewer applications and resulting in a lower haemolysis and acute reconduction rates, which provides potential clinical benefits. A waiting period of 20–30 min for acute CTI reconduction appeared relevant, while adenosine testing did not provide additional value. The findings of the study support considering the flower configuration as a preferable approach and provide an important guide for standardizing PEF-based CTI ablation.

Supplementary material

Supplementary material is available at *Europace* online.

Authors' contributions

(1) Substantial contributions to the conception and design or the acquisition, analysis, or interpretation of the data: P.S. and D.W.
(2) Substantial contributions to the drafting of the articles or critical revision for important intellectual content: P.S., A.B., Š.H., J.P., N.V., D.W., E.B., P.Š., J.H., P.P., R.Č., and J.K.
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Data availability

Data are available from the authors on request.

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