Three-Year Clinical Outcome After 2nd-Generation Cryoballoon-Based Pulmonary Vein Isolation for the Treatment of Paroxysmal and Persistent Atrial Fibrillation — A 2-Center Experience —

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Background: Pulmonary vein isolation (PVI) using the 2nd-generation cryoballoon (CB2) for the treatment of atrial fibrillation (AF) has demonstrated encouraging acute and mid-term results. However, follow-up data on outcomes beyond 1 year are sparse. We investigated the 3-year outcome after PVI using the CB2.

Methods and Results: 100 patients with paroxysmal (PAF, 70/100 [70%] patients) or persistent AF (pAF, 30/100 [30%] patients) underwent CB2-based PVI in 2 experienced centers in Germany. Freeze-cycle duration was 240 s. After successful PVI a bonus freeze-cycle of the same duration was applied in the first 71 patients but was omitted in the following 29 patients. Phrenic nerve palsy occurred in 3 patients (3%); 2 patients were lost to follow-up. After a median follow-up of 38 (29–50) months, 59/98 (60.2%) patients remained in stable sinus rhythm (PAF: 48/70 (69%), pAF: 11/28 (39%) P=0.0084). In 32/39 (77%) patients with arrhythmia recurrence, a second ablation procedure using radiofrequency energy was conducted. Persistent PVI was noted in 76/125 (61%) PVs. After a mean of 1.37±0.6 procedures and a median follow-up of 35 (25–39) months, 77/98 (78.6%) patients remained in stable sinus rhythm (PAF: 56/70 (80%), pAF: 20/28 (71%), P=0.0276).

Conclusions: CB2-based PVI resulted in a 60.2% single-procedure and a 78.6% multiple-procedure success rate after 3 years. Repeat procedures demonstrated a high rate of durable PVI.

Key Words: Atrial fibrillation; Cryoballoon; Long-term follow-up; Pulmonary vein isolation

Pulmonary vein isolation (PVI) has evolved into a widely accepted and effective strategy for the treatment of symptomatic drug-refractory paroxysmal atrial fibrillation (PAF) as well as persistent AF (pAF). Recently, the randomized “Fire And Ice” trial proved non-inferiority to radiofrequency (RF)-based PVI with respect to efficacy and safety. Furthermore, statistically significant advantages in terms of repeat ablations, all-cause re-hospitalization, and cardiovascular re-hospitalization for patients treated with the CB2 were identified. However, although long-term follow-up data after RF-based PVI are available for PAF as well as pAF, the clinical outcome beyond 1 year after PVI utilizing the CB2 are sparse. To our knowledge, the current study is the first reporting on 3-year clinical outcomes following CB2-based PVI in patients with PAF and pAF.

Methods

Patients’ Characteristics and Study Design

Data for all patients referred to 2 electrophysiology centers in Hamburg, Germany (Asklepios Klinik St. Georg and Asklepios Klinik Harburg) between 07/2012 and 04/2013 were analyzed retrospectively. Consecutive patients with
drug-refractory PAF or pAF scheduled for 2nd-generation CB-based PVI were included in the study. AF was defined as paroxysmal if recurrent AF (≥2 episodes) terminated spontaneously within 7 days or AF episodes were terminated by electrical or pharmacological cardioversion within 48 h after AF onset. AF was defined persistent if episodes lasted >7 days or required termination by electrical or pharmacological cardioversion after >48 h from onset.20 Exclusion criteria were prior left atrial (LA) ablation, LA diameter >60 mm, severe valvular heart disease or contraindications to postinterventional oral anticoagulation. Transesophageal echocardiography was performed prior to ablation in all patients to assess the LA diameter and to rule out intracardiac thrombi. No further preprocedural imaging was performed. The local ethics board approved the study. All patients gave written informed consent and all patient information was anonymized.

Intraprocedural Management

The use of CB2 for PVI has been described in more detail. Briefly, all procedures were performed under deep sedation using midazolam, fentanyl and continuous infusion of propofol. Prior to transeptal puncture, a diagnostic catheter was introduced via the right femoral vein and positioned within the coronary sinus. Single transeptal puncture was performed under fluoroscopic guidance using a modified Brockenbrough technique and an 8.5F transseptal sheath (SL1, St. Jude Medical, St. Paul, MN, USA). The transseptal sheath was exchanged over a wire for a 12F steerable sheath (Flexcath Advance, Medtronic). Heparin bolus tagging was performed prior to ablation in all patients to assess the LA diameter and to rule out intracardiac thrombi. No further preprocedural imaging was performed. The local ethics board approved the study. All patients gave written informed consent and all patient information was anonymized.

PVI Using 2nd-Generation Cryoballoon

The CB2 was advanced into the LA over a spiral mapping catheter (AchieveTM, Medtronic). The CB2 was inflated proximal to the PV ostium followed by a gentle push aiming for complete sealing at the antral aspect of the PV. To verify complete PV occlusion, contrast medium was injected through the central lumen of the CB2. If complete occlusion of the individual PV was achieved, the freeze cycle was initiated. Concerning patients with a left common PV (LCPV), a total of 7/14 (50%) LCPVs were isolated during the first CB2 application, and 6/14 (43%) LCPVs were isolated during the second CB2 application. In 1/14 (7%) LCPVs a third CB2 application was necessary to achieve PVI. After successful PVI a bonus freeze-cycle of the same duration was applied in the first 71 patients (“bonus-freeze” protocol: freeze-cycle duration of 240 s followed by an additional bonus freeze-cycle of 240 s duration after proven PVI) but was omitted in the last 29 patients (“no-bonus-freeze” protocol). The procedural endpoint was defined as persistent PVI verified by spiral mapping catheter recordings 30 min after the last energy application.

Postprocedural Care

Following PVI, all patients underwent transthoracic echocardiography to rule out pericardial effusion. All patients were treated with proton-pump inhibitors twice daily for 6 weeks. Low-molecular-weight heparin was administered to patients on vitamin K antagonists and an international normalized ratio (INR) ≤2.0 until a therapeutic INR of 2–3 was achieved. Novel oral anticoagulants were reinitiated 6 h post ablation at half daily dose followed by standard dose the next day. Anticoagulation was continued for at least 3 months and thereafter based on the individual CHA2DS2-VASC score. Previously ineffective antiarrhythmic drugs were continued for 3 months.

Repeat Procedures

In patients admitted for a repeat procedure for recurrence of AF or tachycardia (AT), the re-ablation was performed as previously described. The presence or absence of electrical PV conduction was assessed using a standard spiral mapping catheter. An electroanatomical LA map (CartoTM, Biosense Webster) was generated and the PV ostia were tagged. Reconnection gaps were targeted using a 3.5-mm irrigated-tip catheter (Biosense Webster, Navi-StarTM, Thermo-CoolTM). The procedural endpoint was complete electrical PVI. In patients with persistent isolation of all PVs admitted in sinus rhythm (SR), ostial potentials along previously performed ablation lines were identified and ablated and/or linear lesion sets were applied. In patients admitted in AF or AT and persistent isolation of all PVs, ostial potentials were identified and ablated followed by ablation of complex fractionated atrial electrograms (CFAE) and/or deployment of linear lesion sets dependent on the AT mechanism.

Follow-up

Patients completed outpatient clinic visits at 3, 6 and 12 months and at 6-month intervals thereafter. During these visits a 12-lead surface ECG and 24-h Holter ECGs were performed. In addition interrogation of previously implanted pacemakers as well as dual-chamber implantable cardioverter-defibrillator was performed. Furthermore, telephone interviews were performed and 12-lead ECGs and/or 24-h Holter ECGs were initiated in cases of symptoms suggestive of recurrence of AF/AT. All ECGs Holter ECGs performed during the follow-up period were collected and analyzed. Recurrence was defined as symptomatic and/or documented episodes of AF/AT lasting >30 s. The primary endpoint was defined as recurrence of any symptomatic and documented atrial arrhythmia >30 s following a blanking period of 3 months. Secondary endpoints were defined as procedure-related complications such as PNP, pericardial effusion, cerebral embolism or atrioesophageal fistula.

Statistical Analysis

Continuous data are shown as mean and standard deviation in the case of normally distributed values or as median and interquartile range. Effects of PAF and pAF on recurrence-free survival were examined with the log-rank test in
the case of time to first recurrence. The Anderson-Gill model was used to account for recurrent events after repeated procedures. Survival differences are described with P values and hazard ratios (95% confidence intervals). All P values are two-sided. P<0.05 was considered significant. All data were analyzed using the built-in analysis of GraphPad Prism, Version 5 (GraphPad Software, San Diego, CA, USA).

Results

Patients’ Characteristics
A total of 100 patients (60 male [60%], mean age 62±10 years, mean LA diameter 42±7 mm) with a history of PAF (70/100 [70%] patients) or pAF (30/100 [30%] patients) underwent CB2-based PVI. Baseline characteristics are presented in Table 1.

Procedural Details and Clinical Outcome: Index Procedure
In 100 patients, 386 PVs were identified. A total of 384/386 (99.5%) PVs were successfully isolated using the CB2. No touch-up ablation using RF-energy was necessary in this population. All PVs were successfully isolated with exclusive use of the CB2. Because of PNP during energy application along the RSPV, 2/100 (2%) ipsilateral RIPVs were not targeted. A bonus freeze-cycle was applied after successful PVI in the first 71 patients, but omitted in the last 29 patients. Ablation of the cavotricuspid isthmus (CTI) was performed in 5/100 (5%) patients because of documented typical CTI-dependent atrial flutter. Procedural data are shown in Tables 2.3. The median procedure duration was 100 min (80, 120) and the median fluoroscopy time was 22 min (18, 27). PNP occurred in 3/100 (3%) patients during energy delivery along the RSPV. In all cases PN function recovered within 10 months of follow-up. Other adverse events were 3 patients (3%) with a severe groin hematoma, 1 patient with an asymptomatic pericardial effusion (1%) and 1 patient with postprocedural pericardial tamponade (1%). No cases of symptomatic PV stenosis, stroke/TIA, or atrioesophageal fistula were observed.

Clinical follow-up was obtained in 98/100 (98%) patients; 2/100 (2%) patients were lost to follow-up. Data were obtained by Holter ECGs or from interrogation of previously implanted pacemakers (n=3), as well as dual-chamber implantable cardioverter-defibrillators (n=1). After a median follow-up of 38 months (31, 41 months), including a 3-month blanking period, 59/98 (60.2%) patients remained in stable SR (Figure 1A). In patients with previous PAF, 48/70 (69%) (Figure 1B) and 11/28 (39%) of patients with previous pAF remained in stable SR (Figure 1C). A significant difference was found in the comparison of patients with previous PAF and pAF (P=0.0084, hazard ratio (95% confidence interval)=2.379 (1.249, 4.531)). Median time to AF/AT recurrence was 12 (6–22) months. The time-point of AF/AT recurrence was within 3–6 months post ablation in 14/39 patients (36%), within 7–12 months in 7/39 patients (18%), within 13–24 months in 11/39 patients (28%), and ≥25 months in 7/39 patients (20%). The type of recurrence was PAF (n=16), pAF (n=17) and AT (n=6). A total of 5/70 (7%) patients with initial PAF progressed to pAF. By contrast, there was no regression from pAF to PAF.

Re-_ablation Procedures
A repeat RF-based ablation procedure was offered to all patients with symptomatic AF/AT recurrence (n=39) and performed in 32/39 (82%) patients after a median of 14 (8–30) months following the index procedure. Persistent PVI was verified in 76/125 (61%) PVs. In 53/125 (41%) patients all previously isolated PVs remained isolated. Electrical reconnection of a single PV was noted in 13/32 (41%) patients, and 2 recovered PVs were identified in 10/32 (31%)

Table 1. Baseline Characteristics of Patients Undergoing PVI

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>62±10</td>
</tr>
<tr>
<td>Male sex, n (%)</td>
<td>60 (60)</td>
</tr>
<tr>
<td>LA size, mm</td>
<td>42±7</td>
</tr>
<tr>
<td>Paroxysmal AF, n (%)</td>
<td>70 (70)</td>
</tr>
<tr>
<td>Persistent AF, n (%)</td>
<td>30 (30)</td>
</tr>
<tr>
<td>Duration of AF, months</td>
<td>37±38</td>
</tr>
<tr>
<td>Congestive heart failure, n (%)</td>
<td>3 (3)</td>
</tr>
<tr>
<td>Hypertension, n (%)</td>
<td>67 (67)</td>
</tr>
<tr>
<td>Coronary artery disease, n (%)</td>
<td>14 (14)</td>
</tr>
<tr>
<td>Diabetes mellitus, n (%)</td>
<td>10 (10)</td>
</tr>
<tr>
<td>CHA2DS2-VASc score</td>
<td>1.9±1.4</td>
</tr>
</tbody>
</table>

Values are mean±SD or n (%) as appropriate. AF, atrial fibrillation; LA, left atrium; PVI, pulmonary vein isolation.

Table 2. Acute Ablation Results and Periprocedural Data for Patients Undergoing PVI

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>RSPV</th>
<th>RIPV</th>
<th>LSPV</th>
<th>LIPV</th>
<th>LCPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of PVs, n</td>
<td>100</td>
<td>100</td>
<td>86</td>
<td>86</td>
<td>14</td>
</tr>
<tr>
<td>Isolated PVs, n (%)</td>
<td>100/100 (100)</td>
<td>98/100 (98)</td>
<td>86/86 (100)</td>
<td>86/86 (100)</td>
<td>14/14 (100)</td>
</tr>
<tr>
<td>PVI during initial application, n (%)</td>
<td>88/100 (88)</td>
<td>82/100 (82)</td>
<td>70/86 (81)</td>
<td>86/86 (100)</td>
<td>6/12 (50)</td>
</tr>
<tr>
<td>No. of applications until PVI, n</td>
<td>1 (1, 1)</td>
<td>1 (1, 1)</td>
<td>1 (1, 1)</td>
<td>1 (1, 1)</td>
<td>1 (1, 1)</td>
</tr>
<tr>
<td>Total no. of applications, n</td>
<td>2 (2, 2)</td>
<td>2 (2, 2)</td>
<td>2 (2, 2)</td>
<td>2 (1, 2)</td>
<td>2 (2, 3)</td>
</tr>
<tr>
<td>Mean minimal temperature, °C</td>
<td>−52 (−47, −56)</td>
<td>−48 (−46, −54)</td>
<td>−51 (−46, −56)</td>
<td>−48 (−43, −52)</td>
<td>−54 (−46, −60)</td>
</tr>
<tr>
<td>Mean minimal esophageal temperature, °C</td>
<td>35.5 (34.6, 36.2)</td>
<td>35.2 (31.0, 36.0)</td>
<td>34.4 (32.4, 35.5)</td>
<td>34.4 (25.6, 35.2)</td>
<td>32.6 (25.9, 34.6)</td>
</tr>
<tr>
<td>Mean time to PVI, s</td>
<td>48 (32, 82)</td>
<td>53 (31, 71)</td>
<td>40 (28, 47)</td>
<td>30 (24, 36)</td>
<td>80 (56, 88)</td>
</tr>
<tr>
<td>Rate of real-time PVI recordings, n (%)</td>
<td>38/100 (38)</td>
<td>26/100 (26)</td>
<td>33/86 (38)</td>
<td>30/86 (35)</td>
<td>5/14 (36)</td>
</tr>
</tbody>
</table>

Values are mean (interquartile range) or n (%) as appropriate. PV, pulmonary vein; PVI, pulmonary vein isolation; RIPV, right inferior PV; RSPV, right superior PV; LIPV, left inferior PV; LCPV, left common PV; LSPV, left superior PV.
patients. One patient demonstrated electrical reconduction of 3 PVs (3%) and 3/32 (9%) patients demonstrated reconduction of all 4 PVs. Electrical reconduction was demonstrated in 9/32 (28%) RSPVs, 17/32 (53%) RIPVs, 12/29 (41%) LSPVs, 9/29 (31%) LIPVs and 2/3 (67%) LCPVs. In total, 35 reconduction gaps were identified in 27 patients and distributed as shown in **Figure 2**. Re-isolation of all PVs was successfully performed in 27/27 (100%) patients using irrigated RF-energy. In addition, ablation of ostial potentials was performed in 10/27 (37%) patients. Linear lesions were deployed in 5/27 (19%) patients with AT n=3 mitral isthmus lines, n=2 anterior lines. In 2 patients (7%) CFAE ablation was performed. In 5/32 (16%) patients with persistent isolation of all PVs and documented SR at the time of repeat ablation, ostial potentials were targeted in two patients, an additional anterior line was performed in 1 patient and a mitral isthmus line was ablated in 1 patient. Ablation of the CTI was performed in 10/32 (31%) patients because of documented typical CTI-dependent atrial flutter. The median procedure and fluoroscopy duration was 105 min (90, 130) and 14 min (11, 22), respectively. One patient (3%) suffered from a severe groin hematoma, but no further complications occurred. After a median follow-up of 19 months (12, 31 months), including a 3-month blanking period, 17/32 (53%) patients demonstrated AF/AT recurrence after repeat ablation. Median time to AF/AT recurrence was 17 (9, 27) months. One patient with initial PAF progressed to pAF. Following 1–2 procedures (mean 1.3±0.5) and a median follow-up of 35 months (26, 39 months), including a 3-month blanking period, 75/98 (77%) patients remained in stable SR.

**Procedural Details and Clinical Outcome: Third Procedure**

A third procedure was offered to all patients with AF/AT recurrence after the second procedure (n=17) and was performed in 5/17 (29%) patients after a median of 8 (3–10) months following the second procedure. In 1/5 patients (20%) recovered PV conduction was found. One reconduction gap was located at the antero-inferior aspect of the RIPV and was targeted by RF-energy. In 1 patient only ablation of ostial potentials was performed. For treatment of macro-AT an anterior line was deployed in 2 patients, a mitral isthmus line in 1 patient, and a roof line in another patient. Ablation of the CTI was performed in 1 patient. The median procedure and fluoroscopy duration was 125 min (105, 125) and 13 min (12, 19), respectively. No periprocedural complications occurred. After a median follow-up of 14 months (8, 20 months), including a 3-month blanking period, 3/5 (60%) patients had AF/AT recurrence after the third procedure. One patient with initial PAF progressed to pAF.

Following 1–3 procedures (mean 1.37±0.6) and a median follow-up of 35 months (25, 39 months), including a 3-month blanking period, 3/5 (60%) patients had AF/AT recurrence after multiple procedures (Figure 3B), while patients with previous pAF 20/28 (71%) demonstrated stable SR (Figure 3C). A sig-
significant difference was found when comparing patients with initial PAF and pAF (P=0.0276, hazard ratio (95% confidence interval)=1.878 (1.072, 3.289)). Table 4 summarizes the procedural strategies. The clinical outcomes after each procedure are summarized in Figure 4. Among 77 patients in stable SR and free from AF/AT, 7 (9%) were under antiarrhythmic drug therapy (flecainide: n=5, propafenone: n=2). Of 70 patients with initial PAF, progression to pAF was observed in a total of 7 patients (10%).

**Discussion**

The current study is the first to report on 3-year clinical outcome in patients with PAF and pAF undergoing CB2-based PVI. Single-procedure success was 60.2% and the overall success rate reached 78.6% after multiple (1–3) procedures.

Up-to-date long-term clinical outcome data for PVI in patients with PAF utilizing cryothermal energy are only available for the 1st-generation cryoballon (CB1, Medtronic). Vogt et al reported a moderate single-procedure long-term clinical efficacy of 61.6% freedom from AF in PAF patients after a median of 30 months when utilizing the CB1. 25 Although we observed an overall single-procedure success rate of 60.2% after 38 months, the clinical success rate was 69% when considering only patients with PAF. Our long-term findings are in line with short- and mid-term clinical outcome data after CB2-based PVI, and are consistently better than short- and mid-term results achieved with the CB1 in patients with PAF\(^2\)\(^6\),\(^9\) as well as in those with pAF.\(^5\)\(^7\)

As recently demonstrated, the improved performance of the CB2 translates into a higher rate of durable PV1 (69%) of persistently isolated PVs after 205 days.\(^24\) Utilizing the CB1 the rate of durable PVI was 46% after 144 days.\(^26\) At 61% the recent cohort also showed a high rate of persistently isolated PVs. The herein presented 3-year outcome is based on 2 different ablation protocols. The initial 71 patients were treated using the “bonus-freeze” protocol, applying a 240-s freeze-cycle followed by a systematic bonus freeze-cycle of the same duration once successful PVI was accomplished. The last 29 patients were treated according to a “no-bonus-freeze” protocol, omitting the bonus freeze-cycle after suc-
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Our findings suggested that CB2-based PVI might be able to delay or prevent AF progression, although prospective randomized controlled trials are required to prove these findings.

Study Limitations

The presented findings are based on a 2-center experience enrolling only a limited number of patients in a retrospective fashion. Monitoring for AF/AT recurrence was limited to standard of care 24-hour Holter ECGs. This limitation might overestimate the overall success rate, and closer follow-up (e.g., via implantable loop recorders) may have detected a higher rate of AF/AT recurrences.

Conclusions

The 3-year single-procedure success rate for CB2-based PVI was 60.2% and increased to 78.6% following repeat procedures. In repeat procedures a high rate of durable PVI was demonstrated.

Acknowledgments

We thank Claudia Kalkowsky, Sanela Dzudzevics and Detlef Hennig for their excellent assistance.

Conflict of Interest Disclosures

C.-H.H. received travel grants and speaker’s honoraria by BioVentrix, St. Jude Medical, Biotronik and Medtronic. E.W. is a consultant to Medtronic. K.-H.K. received travel grants and research grants from Biosense Webster, Stereotaxis, Prorhythm, Medtronic, Edwards, Cryocath, and is a consultant to St. Jude Medical, Biosense Webster, Prorhythm, and Stereotaxis. He received speaker’s honoraria from Medtronic. A.M. received speaker’s honoraria and travel grants from Medtronic, Biosense Webster and CardioFocus and took part at the

Table 4. Ablation Summary for PVI

<table>
<thead>
<tr>
<th>Procedure</th>
<th>PVI, n (%)</th>
<th>LA-lines, n (%)</th>
<th>CTI-block, n (%)</th>
<th>CFAE, n (%)</th>
<th>Ostial potentials, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Procedure (CB2) (n=100)</td>
<td>100 (100)</td>
<td>0 (0)</td>
<td>5 (5)</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>2. Procedure (RF) (n=32)</td>
<td>27 (84.4)</td>
<td>7 (21.9)</td>
<td>10 (31.3)</td>
<td>2 (6.3)</td>
<td>12 (37.5)</td>
</tr>
<tr>
<td>3. Procedure (RF) (n=5)</td>
<td>1 (20)</td>
<td>4 (80)</td>
<td>1 (20)</td>
<td>0 (0)</td>
<td>1 (20)</td>
</tr>
</tbody>
</table>

CFAE, complex fractionated atrial electrograms; CTI, cavotricuspid isthmus; LA, left atrium; RF, radiofrequency energy. Other abbreviations as in Tables 2,3.

Figure 4. Flowchart detailing clinical outcomes after each ablation procedure. AF, atrial fibrillation; AT, atrial tachycardia; SR, sinus rhythm.

successful PVI. Recent publications suggest that omitting the bonus freeze-cycle after successful PVI might be equally effective with regard to clinical outcome.\(^3\,6\,22\) Although 1-year clinical outcomes in protocols that include a bonus freeze-cycle range between 76.8% and 83.6%,\(^2\,9\,27\) minimized protocols without a bonus freeze-cycle report similar 1-year clinical efficacy (80.4–82%) after CB2-based PVI.\(^5\,22\)

Furthermore, no differences in PVI durability during repeat procedures was noted when comparing a bonus- and a no-bonus-freeze protocol.\(^24\) Reduction in energy transfer may lower the incidence of complications, shorten procedural and fluoroscopy times and reduce radiation exposure. Although no randomized trial has been conducted, studies comparing both protocols in a non-randomized fashion suggest that omitting the bonus freeze-cycle seems to be equally effective with regard to acute efficacy and mid-term clinical outcome.\(^3\)

As reported for RF-energy-based approaches, PVI is effective for the treatment of PAF whereas long-term clinical outcome in patients with pAF is only moderate.\(^19\) In the present study, subgroup analysis focusing on patients with pAF revealed a 59% freedom of AF/AT recurrence during the 3 years of follow-up. After a maximum of 2 repeat procedures this rate improved to 71%. It is important to note that ablation strategies in pAF are heterogeneous and mainly characterized by ablation of CFAE and/or deployment of linear lesion sets, in addition to PVI. Recent data suggest no benefit of additional ablative strategies beyond PVI in patients with pAF.\(^28\)

Our findings demonstrated a relatively low rate of progression from PAF to pAF (10%) during the 3-year follow-up period. Whether CB2 or RF-energy-based PVI can prevent or delay progression to pAF has yet to be proven in clinical trials. Our findings suggested that CB2-based PVI might be able to delay or prevent AF progression, although prospective randomized controlled trials are required to prove these findings.
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Boston scientific EP fellowship. All other authors have no relevant disclosures.

References


