Heart and Vessels

Dissociated pulmonary vein activity after cryoballoon ablation and radiofrequency ablation for atrial fibrillation: A propensity score matched analysis

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Abstract:	Cryoballoons (CBs) have proven to be effective for achieving pulmonary vein isolation (PVI) in patients with atrial fibrillation (AF). Dissociated PV activity (DPVA) after successful radiofrequency PVI is sometimes observed inside the PV and has been found to prove the achievement of electrical disconnection from the left atrium. However, little is known about the incidence or characteristics of DPVA after CB-PVI. The aim of this study was to compare the incidence and characteristics of DPVA in patients undergoing CB and radiofrequency (RF) ablation for AF. Two hundred ninety-four propensity score-matched patients from 440 consecutive patients who underwent initial catheter ablation for paroxysmal AF were included in the present study (CB-PVI: 147, RF-PVI: 147). DPVA was more frequently observed after CB-PVI than after RF-PVI (32% vs. 19% of

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Response to Reviewers:	Thank you very much for considering our revised manuscript for Heart and Vessels. We thank you for your reviews which have helped us improve the manuscript considerably. Changes in the manuscript are provided in bold below. Response to Comments from Reviewer #2 Reviewer Comment: The authors addressed my comments sufficiently. However, despite not having been yet compared ("the incidence of DPVA and its impact on the ablation outcome in patients undergoing CB and radiofrequency (RF) ablation for AF", as stated as Motivation), the clinical impact and value of the results is limited. Response: Thank you. As you mentioned, we did not directly compare the impact of DPVA on the outcome between after CB and RF ablation. We edited as below, “The aim of this study was to compare the incidence and characteristics of DPVA in patients undergoing CB and radiofrequency (RF) ablation for AF.” Reviewer Comment: Furthermore, I do not agree with the conclusions that the larger isolate area in CB PVI can explain the higher incidence of electrical activation. Response: Thank you. As you mentioned, no previous study did not directly compare the isolated area and incidence of DPVA. However, also no study did not prove that isolated area unrelated to the incidence of DPVA. Even it was not direct comparison, the results of previous studies shows higher incidence of DPVA in wide encircling ablation (12-72%) compared to that in segmental isolation (2–12 %). We deleted these sentences, “Electrical activity should appear more frequently from the larger isolated muscular sleeve.” and “The larger isolated area may affect higher incidence of DPVA after CB-PVI than after individual RF-PVI.” We have edited as below. in Page 11, Line 16. “The difference of isolated area can relate to the incidence of DPVA. (Figure 7) In this study, the isolated areas after CB-PVI were wider than those after segmental RF-PVI using 3D electroanatomical mapping system. In previous studies, wide encircling ablation resulted in a DPVA rate of 12-72% [5-9], while segmental isolation resulted in 2–12 % [4, 10].”

Thank you very much for considering our revised manuscript for ***Heart and Vessels***. We thank you for your reviews which have helped us improve the manuscript considerably. Changes in the manuscript are provided in **bold** below.

<u>Response to Comments from Reviewer #2</u>

<u>Reviewer Comment</u>:

The authors addressed my comments sufficiently.

However, despite not having been yet compared ("the incidence of DPVA and its impact on the ablation outcome in patients undergoing CB and radiofrequency (RF) ablation for AF", as stated as Motivation), the clinical impact and value of the results is limited.

<u>Response:</u>

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Dissociated pulmonary vein activity after cryoballoon ablation and radiofrequency ablation for atrial fibrillation: A propensity score matched analysis

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Abstract

Cryoballoons (CBs) have proven to be effective for achieving pulmonary vein isolation (PVI) in patients with atrial fibrillation (AF). Dissociated PV activity (DPVA) after successful radiofrequency PVI is sometimes observed inside the PV and has been found to prove the achievement of electrical disconnection from the left atrium. However, little is known about the incidence or characteristics of DPVA after CB-PVI. The aim of this study was to compare the incidence and characteristics of DPVA in patients undergoing CB and radiofrequency (RF) ablation for AF.

Two hundred ninety-four propensity score-matched patients from 440 consecutive patients who underwent initial catheter ablation for paroxysmal AF were included in the present study (CB-PVI: 147, RF-PVI: 147).

DPVA was more frequently observed after CB-PVI than after RF-PVI (32% vs. 19% of the PVs, P<0.001), especially in the left superior PV (52% vs. 29%, P<0.001) and left inferior PV (22% vs. 7%, P<0.001). The AF-free rate after the initial ablation in the patients with and without DPVA was similar in both the CB (P=0.23) and RF (P=0.39) groups. During repeat ablation procedures for recurrent AF, PV reconnection was similarly observed in PVs with and without DPVA during initial procedure both in the CB (30% vs. 44%, P=0.29) and RF (65% vs. 58%, P=0.41) groups.

DPVA was more frequently observed after CB-PVI than after RF-PVI. The presence of DPVA was not related to the ablation outcome or chronic PV reconnection following CB-PVI.

Keywords

Dissociated pulmonary vein activity, Cryoballoon ablation, Radiofrequency ablation, Pulmonary vein isolation, Atrial fibrillation

Introduction

Pulmonary vein isolation (PVI) is the cornerstone of catheter ablation for atrial fibrillation (AF), especially in patients with paroxysmal AF [1]. In addition to radiofrequency (RF) ablation, cryoballoon (CB) ablation has proven to be an effective therapy for PVI in patients with paroxysmal AF. Two randomized trials have shown the noninferiority of CB ablation in comparison to RF ablation with respect to the treatment efficacy in patients with drug-refractory paroxysmal AF [2, 3]. Furthermore, the overall safety of the two types of procedures did not differ to a statistically significant extent.

Dissociated PV activity (DPVA) after successful PVI is observed inside 2-72% of PVs and has been found to prove the achievement of electrical disconnection from the left atrium [4-10]. Previous studies demonstrated the occurrence of DPVA after RF-PVI was related to acute PV reconnection at 30-min after PVI [5], and was shown to improve the long-term ablation outcome and be an indicator of successful durable isolation of the PVs [7]. The characteristics of DPVA can differ according to the ablation method such as segmental and circumferential PVI. Although implication of DPVA after RF-PVI was reported by several reports, little is known about the characteristics of DPVA in patients undergoing CB-PVI. The aim of the present study was to compare the incidence and characteristics of DPVA in patients undergoing CB or RF ablation for AF.

Materials and methods

Study Subjects

The study population included a total of 440 patients who had undergone an initial catheter ablation procedure for paroxysmal AF, between January 2013 and June 2016. The decision to perform RF ablation versus CB ablation was based on the preference of each individual operator. The patient with common PV and right middle PV was excluded from the study. All of the patients underwent an enhanced CT-scan prior to ablation to establish the anatomy of the LA and PV. Antiarrhythmic drugs were discontinued for at least 5 half-lives prior to ablation. Transesophageal echocardiography was performed prior to the procedure to rule out LA thrombus. In the present study, "paroxysmal AF" was defined as AF that spontaneously terminated within 7 days. The studies and data collection were performed according to protocols that had been approved by the Human Research Committee of the Jikei University School of Medicine.

The Catheter Ablation of AF

Each patient gave their written informed consent. Heparin (100 IU/kg body weight) was administered immediately after obtaining venous access; heparinized saline was also infused to maintain an activated clotting time of 250–350 seconds. The procedures were performed under mild sedation with flunitrazepam and propofol. An esophageal temperature probe (Sensitherm, St. Jude Medical Inc., Minneapolis, MN, USA or Esophastar, Japan Lifeline) was inserted throughout the ablation procedure to avoid esophageal injury.

Radiofrequency PV Isolation

An electrophysiological study was performed as previously described under institutional approval [11]. The LA and PVs were explored through either a patent foramen ovale or transseptal catheterization with 3 catheters (2 for circumferential PV mapping and 1 for ablation). The direct visualization of all 4 PVs was performed using selective venography. The PV antrum was determined using a direct PV visualization 3-dimensional mapping system (CARTO, Biosense Webster, Diamond Bar, CA, USA, or Ensite NavX, St. Jude Medical). PV mapping was performed with a 20-polar circular catheter (Lasso® 2515 NAV eco variable catheter, Biosense Webster).

All 4 PVs were individually targeted for disconnection from the LA. RF energy was delivered at the PV antrum for 30–60 seconds using an open irrigated-tip ablation catheter with a power limit of 25-35 W. The endpoint of the PVI was the establishment of a bidirectional conduction block between the LA and the PV. The exit block was confirmed by pacing inside the PV with a Lasso catheter. The absence of acute conduction recovery between the PVs and the LA was confirmed in each PV after waiting at least 30 minutes after the final RF application.

Cryoballoon Ablation

A single transseptal puncture was performed using an RF needle (Baylis Medical, Montreal, QC, Canada) and an 8-Fr long sheath (SL0, AF Division, St. Jude Medical). The transseptal sheath was exchanged over a guide wire for a 15-Fr steerable sheath (Flexcath Advance, Medtronic). A 20–30 mm circular mapping catheter (Lasso) was used for mapping all of the PVs before and after the CB to confirm electrical isolation. PVI was performed with a single balloon technique using a second-generation CB (Arctic Front Advance, Medtronic, Minneapolis, MN, USA). In the CB group, a 28-mm CB catheter was used for all patients. A spiral mapping catheter (Achieve®, Medtronic) was used to advance the CB and to map the PV potentials. Complete sealing at the antral aspect of the PV was confirmed by the injection of contrast medium. This was followed by a freeze cycle of 180 seconds. In order to avoid phrenic nerve injury [12], the diaphragmatic compound motor action potentials (CMAP) were monitored during phrenic nerve pacing while all of the CB applications were applied [13]. The procedural endpoint was defined as the establishment of a bidirectional PV-LA block, which was verified by a 20–30 mm circular mapping catheter. If electrical isolation was not achieved by a total of 3 CB applications (180 seconds for each application) per vein, additional touch-up ablation was performed with a conventional RF or cryothermal (Freezer Max, Medtronic) catheter. The voltage map was created before and after ablation to assess isolated are. The mapping of LA and PV was obtained using circular mapping catheter with the Ensite Navx (St. Jude Medical Inc.) or CARTO (Biosense Webster). The scale on the voltage map was set from 0.2 to 1.2 mV. Scar area was defined as the area with the voltage < 0.2mV. The surface area of the LA and PV were calculated using the algorithm included in the 3 D mapping system as shown in the previous study [14].

ATP Testing after Pulmonary Vein Isolation

All PVs were isolated and the mapping catheter was kept in the PV for at least 5 minutes after isolation. In all patients of both the RF and CB groups—after waiting for at least 30 minutes after the final application of PVI—adenosine triphosphate (20 mg) was rapidly administered intravenously to induce dormant PV conduction under the continuous infusion of isoproterenol (20 μg/min) during sinus rhythm (for the right superior [RS] PV and the right inferior [RI] PV) or coronary sinus pacing (for the left superior [LS] PV and left inferior [LI] PV). Additional radiofrequency or cryothermal ablation was applied until dormant conduction was eliminated.

Definition of Dissociated PV activity

DPVA was defined as at least two PV potentials without propagation to the LA after PVI, which occurred spontaneously, and which was not induced by the manipulation of catheters. This phenomenon had to be observed in sinus rhythm at least 30 minutes after the successful isolation of the veins using conventional circular mapping catheters in each PV for 5 minutes. The rhythms in the PV were classified according to a previous report [6]: (1) silent, there was no electrical activity; (2) isolated ectopic beats, there were intermittent potentials without a regular rhythm; (3) regular ectopic rhythm (Figure 1) or (4) fibrillatory activity (Figure 2).

Patient Follow-up

No antiarrhythmic drugs were prescribed after the procedure. The patients underwent continuous, in-hospital ECG monitoring for 2–4 days after the procedure. The patients were carefully observed (2 weeks after discharge, then every month) at the cardiology clinic. The outcome of AF ablation was evaluated based on the patient's symptoms, ECG at the periodical follow-ups, and by periodic 24-hour ambulatory monitoring (at 1, 3, 6, 9, and 12 months after the procedure). A cardiac event recorder or a portable electrocardiogram was used to define the causes of symptoms that were suggestive of tachycardia. The recurrence of AF was defined as AF lasting for more than 60 seconds after a blanking period of 90 days.

Statistical Analysis

Propensity scores were calculated for each of the 414 patients based on a multivariable logistic regression model. A total of 15 characteristics that were hypothesized to be associated with the outcome of catheter ablation were assessed for inclusion in the model as independent variables. All 15 characteristics were retained in the model with stepwise selection and were subsequently used to generate propensity scores. The selection process used a P value cutoff of 0.05 for a characteristic to be included in the model. In order of stepwise selection, the matching variables were as follows: sex, age, body mass index, LA diameter, left ventricular ejection fraction, estimated glomerular filtration rate, B-type natriuretic peptide, history of AF, hypertension, diabetes mellitus, obstructive sleep apnea, congestive heart failure, coronary artery disease, the number of AAD and CHADS2 score. Based on their propensity score, the patients who underwent CB-PVI were matched on a 1:1 basis with patients who underwent RF-PVI using a nearest neighbor algorithm without replacement using a caliper width equal to 1/5 of the standard deviation of the logit of the propensity score.

Continuous variables were expressed as the mean ± standard deviation. An unpaired Student's *t*-test or the Mann-Whitney U test was used for the analysis of continuous variables. The categorical variables, which were expressed as numbers or percentages, were analyzed using the chi-squared test unless the expected values in any cells were <5, in which case Fisher's exact test was used. P values of <0.05 were considered to indicate statistical significance. Survival curves were created using the Kaplan–Meier method and comparisons between groups were performed using a log-rank test. All of the statistical analyses were performed using the SPSS software program (version 23.0.0; SPSS, Chicago, IL).

Results

Patient Characteristics and Procedural Details

CB and RF ablation were performed in 191 and 249 patients, respectively. The resulting propensity score matched data set included 294 patients—147 underwent CB-PVI and 147 underwent RF-PVI. The mean age of the patients was 57.3 ± 10.2 years and the mean LA diameter was 36.6 ± 5.2 mm. There were no significant differences between the two groups with regard to the baseline patient characteristics (Table 1).

The total procedure time (142 ±32 min vs. 172 ± 48 min, P<0.001) and the fluoroscopic time (62 ±18 min vs. 99 ±33 min, P<0.001) were significantly shorter in the CB ablation than in the RF ablation (Table 2). While the PV was successfully isolated in all cases in the RF group, PVI by CB alone failed—thereby necessitating touch-up ablation—in 8% (46/588) of the PVs in the CB group. Touch-up ablation was most frequently required in the RIPV (LSPV: 6% (9/147 PVs), LIPV: 9% (13/147 PVs), RSPV: 0% and RIPV: 18% (24/147 PVs)). The mean area of post-ablation scar was larger after CB-PVI than after RF-PVI (14.4 ± 2.2 cm^2 vs. 11.4 ± 2.6 cm^2, P=0.01).

DPVA after PVI

DPVA was observed in 26% of all PVs (1.1 PVs/patient). DPVA was more frequently observed after CB-PVI than after RF-PVI (32% (1.3 PVs/patient) vs. 19% of the PVs (0.8 PVs/patient), P<0.001; Figure 3). After CB-PVI, superior PVs presented DPVA more frequently than inferior PVs (45% vs. 18%, P<0.001), as well as DPVA after RF ablation (30% vs. 10%, P<0.001). With regard to the individual PVs, DPVA was more frequently observed after CB-PVI than after RF-PVI in the LSPV (52% vs. 29%, P<0.001) and the LIPV (22% vs. 7%, P<0.001), but was similarly observed in the RSPV (37% vs. 31%, P=0.33) and the RIPV (15% vs. 12%, P=0.39) (Figure 3). The types of DPVA are shown in Figure 4. Dissociated ectopic beat and ectopic rhythm were more frequently observed after CB-PVI than after RF-PVI (21% vs. 15%, P=0.007, 10% vs. 4%, P=0.0001, respectively). Among the PVs with a regular dissociated rhythm, the mean cycle length of the dissociated rhythm in the RF and CB groups did not differ to a statistically significant extent (2209 ± 986 ms vs. 1869 ± 825 ms, P=0.16). PV fibrillation was not observed in the CB group. DPVA was similarly observed in the PVs required touch-up ablation and these not required (13/46 PVs (28.3%) vs. 179/542 PVs (33.0%), P=0.51).

Ablation Outcome and durability of PVI

During a mean of 12 ± 6 months follow up, the AF-free rate after the initial procedure in the patients with and without DPVA did not differ to a statistically significant extent in either the CB or RF groups (P=0.23 and P=0.39, respectively; both Figure 5). Among the 294 propensity score-matched patients, 5 (3%) patients in the CB group and 9 (6%) patients in the RF group underwent a repeat ablation procedure for recurrent atrial tachyarrhythmia. During the repeat ablation procedure, PV reconnections were less frequently observed after CB ablation than after RF ablation (36% vs. 62% of PVs, P=0.02, Figure 6). PV reconnection was similarly observed in PVs with and without DPVA in the index ablation procedure, both in the CB (30% vs. 44%, P=0.29) and RF groups (65% vs. 58%, P=0.41, Figure 6). In 16 of 30 PVs without DPVA at the first procedure, DPVA was observed during repeat procedure. On the other hand, 13 of 25 PVs with DPVA at first procedure still presented DPVA during repeat procedure.

Discussion

Main Findings

This study resulted in several important findings. First, DPVA was more frequently observed in the patients who underwent CB-PVI than in those who underwent RF-PVI. Second, the presence of DPVA was not associated with the ablation outcome in the CB or RF groups. Third, PV reconnection in repeat procedure was similar between PVs with and without DPVA in the index procedure. To the best of our knowledge, this is the first study to assess the details of DPVA after CB-PVI and compare with those after RF ablation.

Incidence of Dissociated PV Firing

Reported incidence of DPVA after RF-PVI showed a broad variation from 2 to 72% of PVs [4-10]. Differences in the definition of DPVA are probably the main reason of the broad variations. We observed DPVA in 19% of PVs after RF ablation. DPVA was more frequently observed in superior PVs than in the inferior PVs. This may be due to the longer and thicker muscular sleeves of the superior PV [15]. The difference of isolated area can relate to the incidence of DPVA. (Figure 7) In this study, the isolated areas after CB-PVI were wider than those after segmental RF-PVI using 3D electroanatomical mapping system. In previous studies, wide encircling ablation resulted in a DPVA rate of 12-72% [5-9], while segmental isolation resulted in 2–12 % [4, 10]. The methods of RF-PVI (individual or circumferential) may also affect the result of this study.

The different energy sources of two ablation methods also may affect the incidence of DPVA. Several previous studies have demonstrated that CB ablation may create lesions that are more homogeneous and extensive in comparison to those created by RF ablation. The higher levels of cardiac troponin I and creatinine kinase-MB that are generally present after CB-PVI in comparison to RF-PVI indicate that a greater degree of inflammation occurs during CB-PVI [16]. Moreover, we previously reported that ATP-induced dormant conduction was less frequently provoked after CB ablation than after RF ablation [14]. Because the mechanism of ATP-induced dormant conduction is considered to be the restoration of conduction in damaged—but viable—myocardial tissues [17], the lower prevalence of dormant conduction indicates that CB-PVI can make lesions that are more homogeneous and extensive in comparison to those made by RF-PVI. Greater myocardial injury may affect the activity in the PV myocardial sleeves distal to the ablation line in the acute period.

Adrenergic agents to induce acute PV reconnection and dormant PV conduction must have an effect on the incidence of DPVA. However, influence of the administered agent was considered to be small because a similar dose of isoproterenol (20 µg/min) was continuously infused after PVI in both groups.

Presence of DPVA and the Ablation Outcome

In the literature, the association between DPVA and ablation outcomes has been controversial. Several studies demonstrated that the presence of DPVA was a successful indicator of durable PVI and was associated with an improved ablation outcome [7, 18, 19]. However, other reports revealed no relationship between this phenomenon and arrhythmia-free survival [8, 9]. In our study, DPVA was no clinical predictor for AF recurrence after CB or RF ablation. Most patients with a failed initial ablation procedure have resumption of PV conduction. No significant relationship between DPVA and the durability of PVI in repeat ablation procedure might explain the contracting results. Although DPVA after PVI is an important electrophysiological finding to ensure LA-PV bidirectional conduction block, clinical implications might be limited.

Study limitations

The present study is associated with several limitations. This study was a non-randomized, observational, study that was performed in a single institution. The results of propensity score matching in this study are only generalizable among patients in the range of propensity scores that were included in the paired analysis, and may not be applicable to patients who are outside this range. Propensity score methods can reduce bias in causal estimates due to observed differences between groups, but they are still subject to biases from unobserved differences. The incidence of DPVA can be affected by time and autonomic nerve system. Detection of DPVA might be dependent on the positioning of the circumferential mapping catheter. We usually located circular mapping catheter on PV antrum. PV antrum is defined as the proximal portion next to the tubular PV as observed on the selective PV angiogram or intracardiac echocardiogram. Since we pursued to locate the circular mapping catheter in similar position in both groups, the influence of the catheter position to the results cannot be denied.

Further study with longer observation period may improve the reliability of the results. Because the number of patients who underwent repeat ablation procedures was small, the statistical reliability regarding PV reconnection during repeat ablation procedures was limited.

Conclusion

The DPVA occurred more frequently after CB-PVI than after RF-PVI. The presence/absence of DPVA was not associated with the ablation outcome or chronic PV reconnection after the CB or RF ablation procedures.

Conflict of interest

The authors declare no conflicts of interest in association with the present study.

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Figure legends

Figure 1.

A representative case of regular ectopic rhythm in an isolated pulmonary vein (PV).

Regular dissociated potentials were observed in the PV.

CS, coronary sinus; prox, proximal; dis, distal.

Figure 2.

A representative case of fibrillatory activity in an isolated PV.

Fibrillatory firing was observed in the PV. However, it did not conduct to the atrium.

The abbreviations are the same as in the previous figure.

Figure 3.

The incidence of dissociated PV activity (DPVA) after CB-PVI or RF-PVI.

PVI, pulmonary vein isolation; LSPV, left superior pulmonary vein; LI, left inferior; RS, right superior; RI, right inferior. The other abbreviations are the same as in the previous figures.

* Statistically significant ($P<0.05$).

Figure 4.

The characteristics of DPVA after PVI.

The abbreviations are the same as in the previous figures.

Figure 5.

The AF-free rate after the initial ablation procedure according to the presence of DPVA after the index ablation procedure.

Kaplan-Meier curves showing the AF-free rate after the initial CB (left panel) and RF (right panel) ablation procedures according to the presence of DPVA.

The other abbreviations are the same as in the previous figures.

Figure 6.

Incidence of PV reconnection in repeat ablation procedure.

The abbreviations are the same as in the previous figures.

Figure 7.

Left panel: A representative position of circular catheter in PV.

Middle panel: Ablation sites and the virtual isolation line (dotted red line) of RF PVI.

Right panel: Freezing sites and the virtual isolation line (dotted red line) of CB PVI.

Abbreviations are the same as in the previous figures.

Table 1.

The characteristics of the patients who underwent cryoballoon and radiofrequency ablation

	All N=294	Cryoballoon ablation (n=147)	Radiofrequency ablation (n=147)	*P* value
Sex (male)	253 (86%)	127 (86%)	126 (86%)	0.87
Age (years)	57.3 ± 10.2	57.0 ± 11.0	57.6 ± 9.6	0.62
BMI	23.7 ± 3.1	23.6 ± 3.1	23.7 ± 3.1	0.57
LA diameter (mm)	36.6 ± 5.2	36.4 ± 4.7	36.7 ± 5.6	0.68
LV ejection fraction (%)	64.8 ± 5.0	64.8 ± 4.8	64.8 ± 5.2	0.99
eGFR (ml/min/1.73m^2)	75.5 ± 13.1	75.6 ± 12.8	75.5 ± 13.5	0.92
Hypertension	98 (33%)	49(33%)	49 (33%)	1.00
Diabetes Mellitus	26 (9%)	13 (9%)	13 (9%)	1.00
Obstructive sleep apnea	32 (11%)	18 (12%)	14 (10%)	0.67
Congestive heart failure	10 (3.4%)	5 (3.4%)	5 (3.4%)	1.00
Coronary artery disease	14 (4.8%)	6 (4.1%)	8 (5.4%)	0.58
BNP (pg/ml)	41.7 ± 59.9	40.3 ± 59.0	43.0 ± 60.9	0.70
No. of AAD	1.0 ± 0.8	1.0 ± 0.8	1.0 ± 0.8	0.89
$CHADS_2$ Score	0.6 ± 0.8	0.6 ± 0.8	0.6 ± 0.8	1.00
AF history (years)	3.0 ± 3.7	3.2 ± 4.1	2.8 ± 3.2	0.06

The data are presented as the mean ± SD or n (%).

LA, left atrium; LV, left ventricle; eGFR, estimated glomerular filtration rate; BNP, B-type natriuretic peptide; AAD, anti-arrhythmic drug.

Table 2

The procedural details

	Cryoballoon ablation	Radiofrequency ablation	*P* value
Total procedure time (min)	143 ± 32	172 ± 48	<0.001
Total fluoroscopic time (min)	62 ± 18	99 ± 33	<0.001
Ablation time (s)			
LSPV	314 ± 163	454 ± 246	<0.001
LIPV	255 ± 122	271 ± 161	0.33
RSPV	254 ± 96	567 ± 280	<0.001
RIPV	259 ± 122	410 ± 239	<0.001

The data are presented as the mean ± SD.

LSPV, left superior pulmonary vein; LI, left inferior; RS, right superior; RI, right inferior. The other abbreviations are the same as in the previous tables.

Figure 1 Click here to download Figure Figure1.jpg

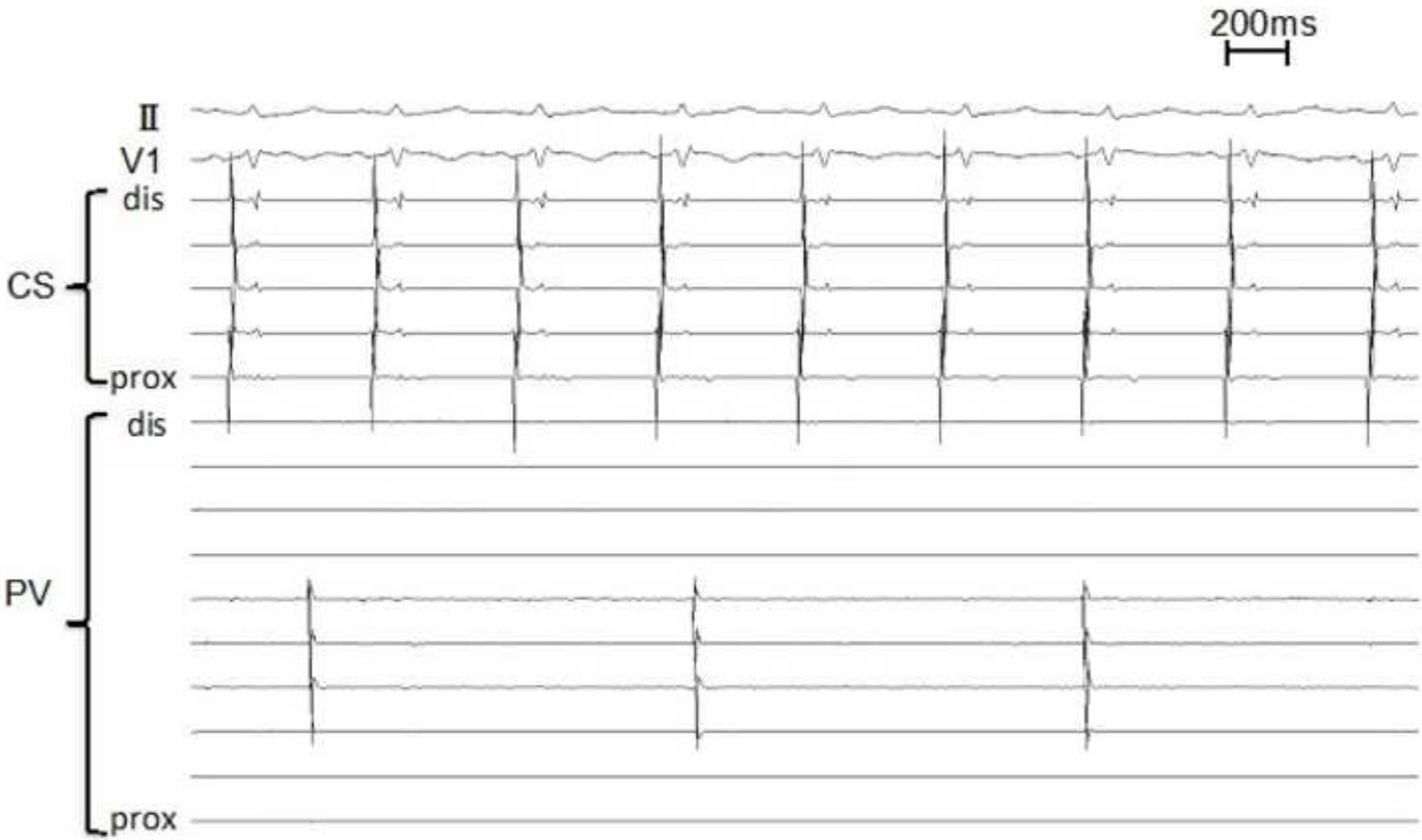

Figure 2

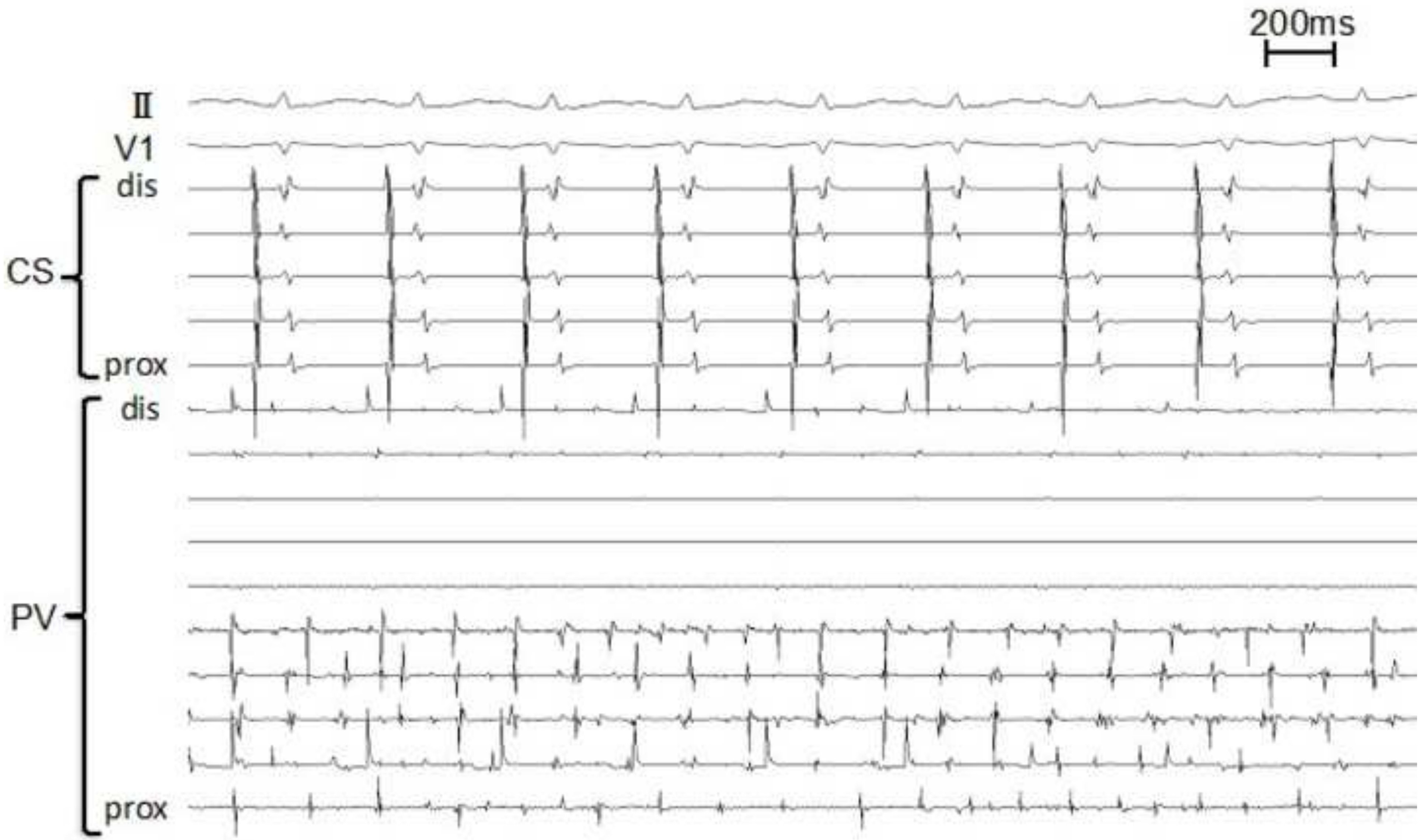

Figure 3

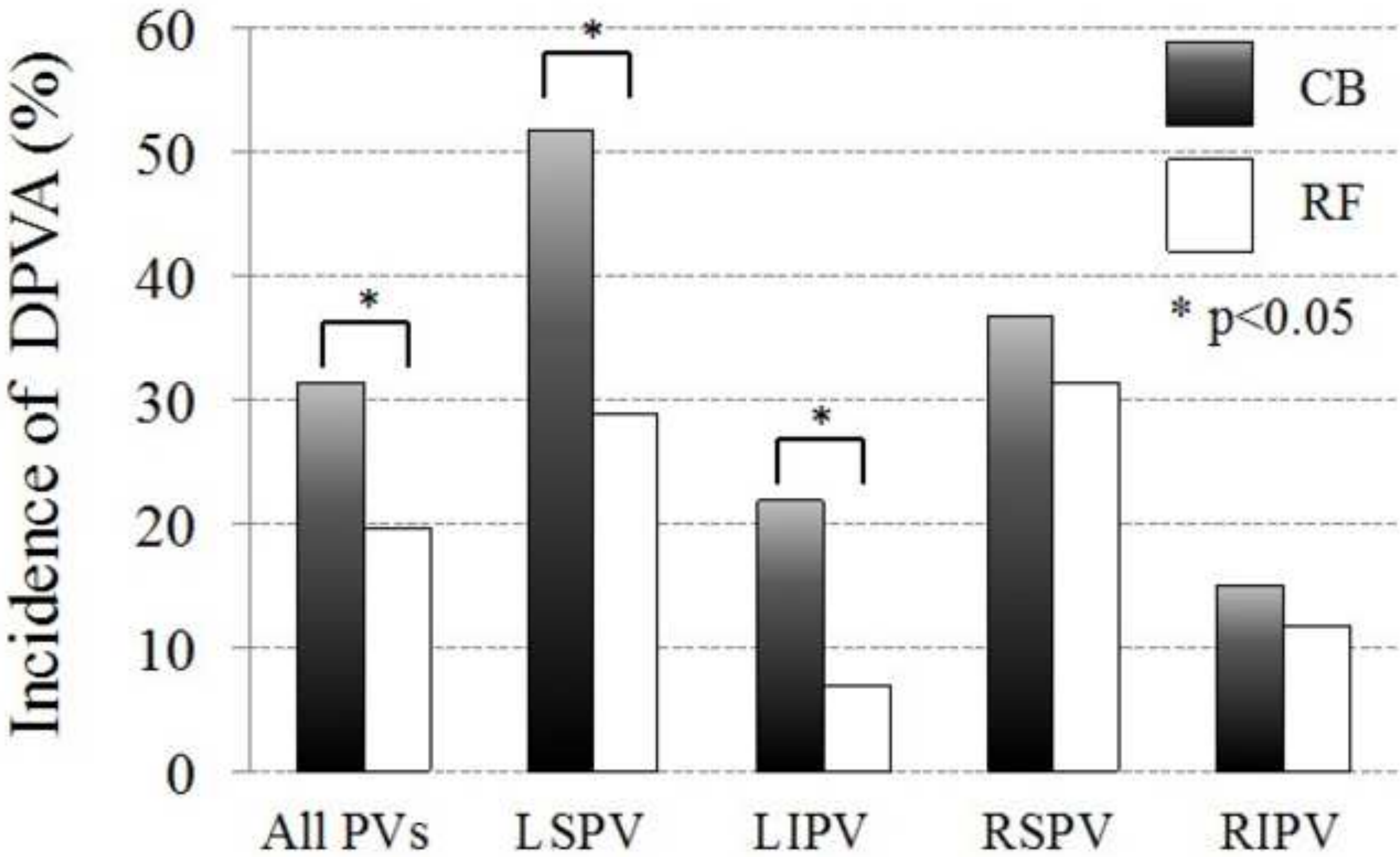
Incidence of DPVA (%)
60
50
40
30
20
10
0
All PVs
LSPV
LIPV
RSPV
RIPV
CB
RF
* p<0.05
*
*
*

Figure 4

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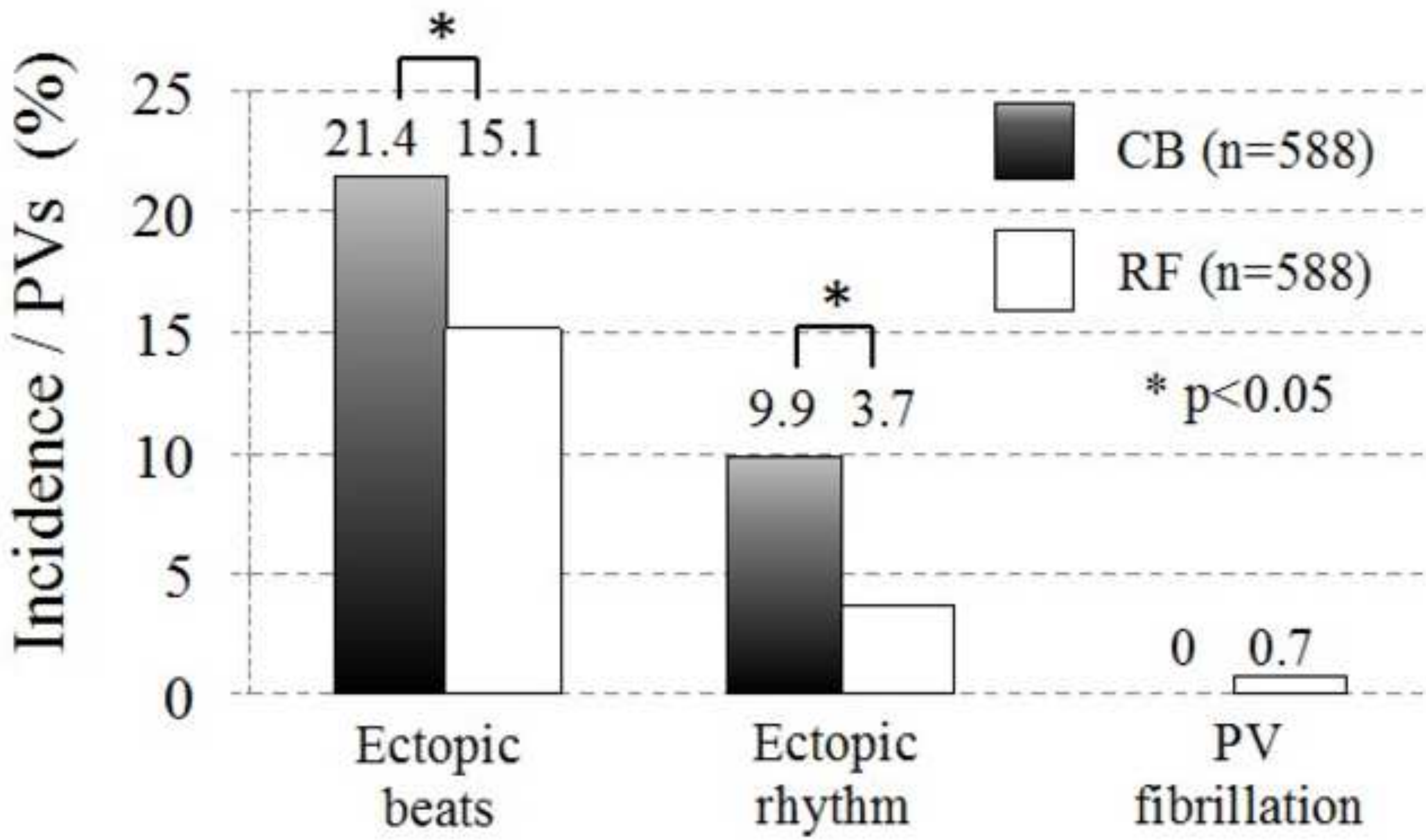

Figure 5 Click here to download Figure Figure5.jpg

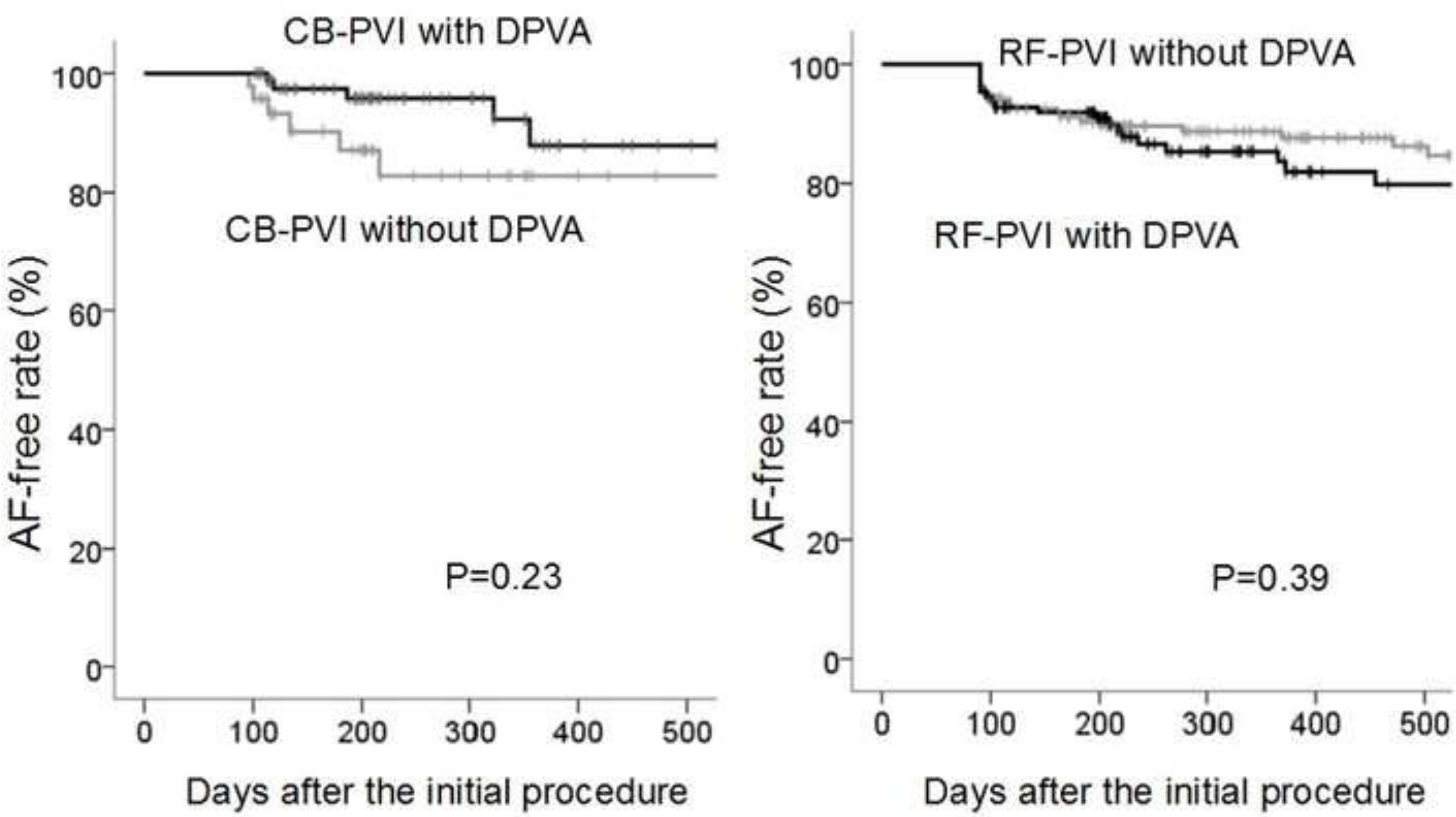

Figure 6

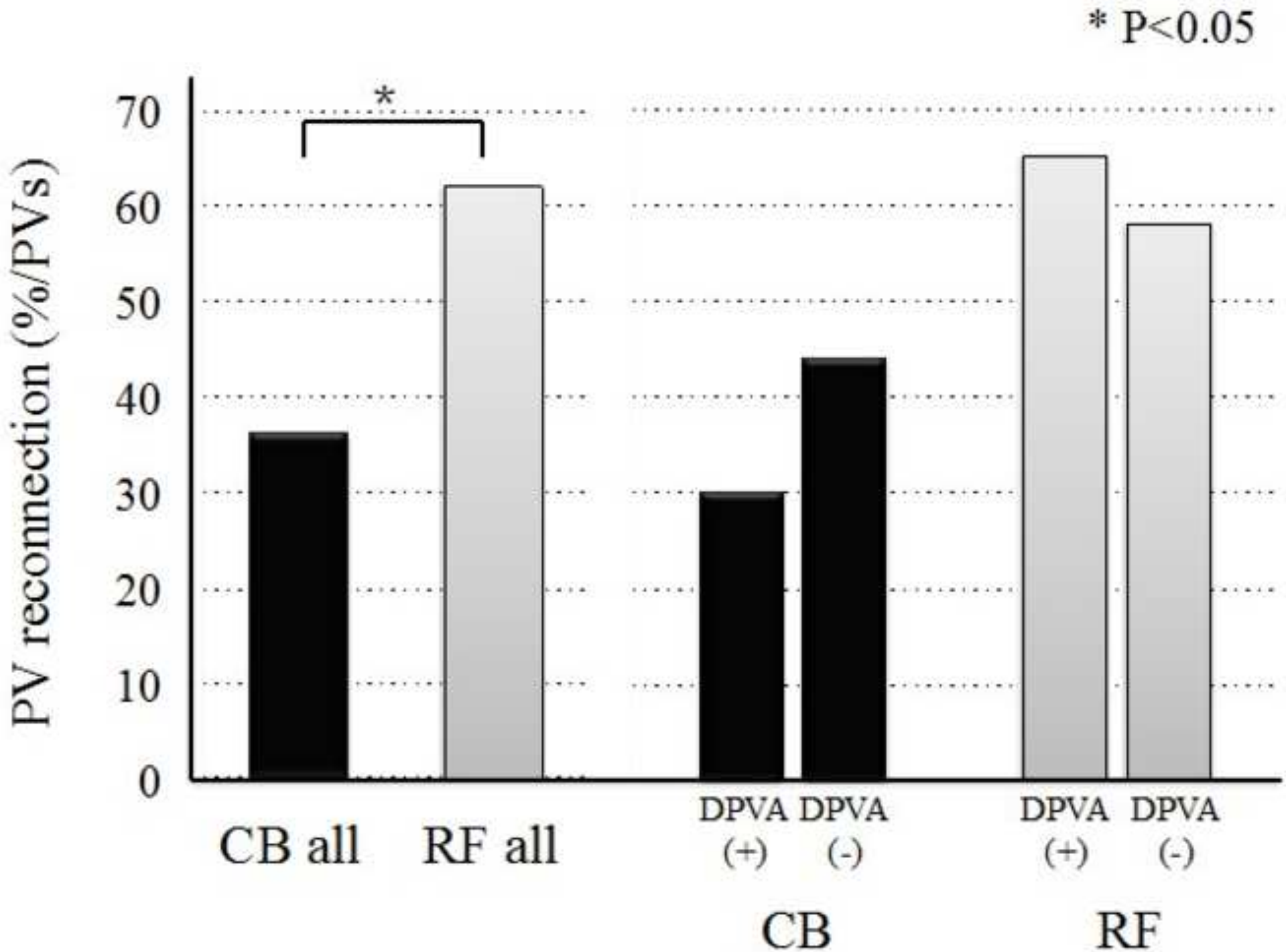
* P<0.05
PV reconnection (%/PVs)
70
60
50
40
30
20
10
0
*
CB all
RF all
DPVA (+)
DPVA (-)
CB
DPVA (+)
DPVA (-)
RF

Figure 7 Click here to download Figure Figure7.jpg