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Original article

Clinical implications of and factors influencing dissociated pulmonary vein potentials

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ABSTRACT

Background: Factors influencing dissociated pulmonary vein (PV) potentials (DPVPs) in atrial fibrillation (AF) patients undergoing circumferential PV isolation have not been investigated. Furthermore, the clinical implications of such DPVPs remain controversial.

Methods: Circumferential PV isolation as a first ablation procedure was performed in 688 consecutive patients with AF (460 men; mean age, 58.9 ± 10.5 years). The clinical implications of and factors influencing DPVPs were evaluated.

Results: Acute PV isolation was achieved in 679 (98.7%) patients. A total of 578 (42.6%) ipsilateral PVs with DPVPs were documented in 378 (55.7%) patients (DPVPs group). Multivariate analysis revealed that male gender [odds ratio (OR): 1.894; 95% confidence interval (CI): 1.344–2.667; $p < 0.001$] and paroxysmal AF (OR: 1.715; 95% CI: 1.182–2.488; $p = 0.005$) were independent factors for DPVPs. The incidence of acute and intraoperative PV reconnection (PVR) was higher in the DPVPs group than in the non-DPVPs group (33.1% vs. 17.9%; $p < 0.001$ and 44.4% vs. 28.2%; $p < 0.001$). After the first procedure, 244 (65.6%) DPVPs-group patients and 168 (56.4%; $p = 0.015$) non-DPVPs group patients were free from AF recurrence. During repeat procedures, PVR incidence was similar in the DPVPs group (81.8%) and non-DPVPs groups (83.3%; $p = 0.863$).

Conclusion: Male gender and paroxysmal AF were independent risk factors for DPVPs in patients undergoing circumferential PV isolation. DPVPs had a significant impact on acute and intraoperative PVR. The outcomes of the first ablation procedure were better in patients with DPVPs.

Introduction

Electrical isolation of the pulmonary veins (PVs) has been considered the cornerstone of catheter ablation for the treatment of atrial fibrillation (AF) [1–4]. Dissociated PV potentials (DPVPs) of a primarily slow and repetitive nature within the PVs, a demonstration of PV exit block and entrance block, are accepted as a sign of electrical disconnection of the PVs from the left atrium (LA) during PV isolation [5,6]. The incidence of DPVPs during PV isolation ranges from 9% following segmental isolation to 40% following antral isolation [5,7]. Studies have suggested that PVs with DPVPs, or arrhythmogenic PVs, are more likely to have an extensive connection with the LA and be associated with early AF recurrence [8–10]. However, apart from the type of procedure, factors that influence the occurrence of DPVPs have not been investigated. Furthermore, the impact of such DPVPs on PV reconnection (PVR) remains controversial and has not been systematically assessed in a large sample. Therefore, in this study, we identified the factors that influence the occurrence of DPVPs and evaluated the clinical implications of such DPVPs in AF patients who underwent circumferential PV isolation as a first ablation procedure.

Methods

Study population

The study population consisted of 688 consecutive patients (460 men; mean age, 58.9 ± 10.5 years) with paroxysmal or

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persistent (including long-standing persistent), drug-refractory AF who were scheduled to undergo their first ablation procedure between February 2007 and January 2011. Paroxysmal and persistent AF were defined according to the expert consensus statement [4]. Written informed consent was obtained from every patient.

Preoperative preparation and ablation procedure

The preoperative preparation has previously been described in detail [11,12]. The ablation procedure was performed while patients were under sedation with a bolus of midazolam and analgesia with a continuous infusion of fentanyl [11].

The protocol of AF ablation has previously been described in detail [11,12]. A multipolar electrode 6F catheter was positioned in the coronary sinus (CS). A transseptal puncture was performed, and two long sheaths were placed in the LA. Electroanatomical mapping and ablation were performed with a 3.5-mm-tip catheter (ThermoCool Navi-Star, Biosense Webster, Diamond Bar, CA, USA). Image integration with the reconstructed computed tomography scan was performed. Circumferential PV isolation was performed just outside the ostia of the ipsilateral PVs. A circular mapping catheter (Lasso, Biosense Webster) was placed within the superior or inferior PV or within the branches of a common PV to identify the breakthrough region of the LA to PV conduction and to guide gap ablation for PV isolation. If AF persisted, linear ablation and complex fractionated atrial electrogram ablation were performed if necessary. Electrical or drug cardioversion was attempted to restore sinus rhythm when AF termination could not be achieved with the abovementioned steps. After cardioversion, bidirectional conduction block of all the ablation lines was checked, and reinforcement ablation was performed, if necessary, to confirm the bidirectional conduction block.

Irrigated radiofrequency energy was delivered with an upper temperature limit of 43 °C, a maximum radiofrequency power of 38 W and an infusion rate of 17–25 ml/min. In all patients, the maximal power delivered to the superior vena cava and the CS was set at 25 W, to minimize the risk of cardiac tamponade or phrenic nerve impairment. The maximal power delivered to the posterior wall was set at 35 W, to minimize the risk of esophageal injury.

Identification and evaluation of DPVPs and PVR

Immediately after the ipsilateral PVs were isolated, the electrical activities in the isolated veins were assessed by placing the Lasso catheter within each PV of the ipsilateral PVs for 5 min in each PV. After placement and stabilization of the Lasso catheter, the 5-min recording period was started, and the Lasso catheter was not moved during this period. DPVPs were defined as sharp and high-frequency potentials that were not associated with the far-field atrial potentials or with manipulation of the catheters (Fig. 1). For paroxysmal AF, isoproterenol was used to detect DPVPs after PV isolation during the initial procedure. Patients with DPVPs were assigned to the DPVPs group and those without such DPVPs were assigned to the non-DPVPs group.

After the recording period, the Lasso catheter was placed within the PVs (in the PVs with more frequent DPVPs if more than one ipsilateral vein had DPVPs, or in the superior PV if no DPVPs were documented in the ipsilateral PVs) for at least 30 min (including the 5 min observation period for each PV in the ipsilateral PVs) to evaluate and document the DPVPs and PVR (Fig. 2). Acute PVR was defined as re-conduction with the LA within 30 min after isolation. Intraoperative PVR was defined as PVR occurring during the ablation procedure, including acute PVR. The timing of PVR was also documented.

For those patients who underwent a repeat procedure for recurrent atrial arrhythmias, the presence or absence of DPVPs was

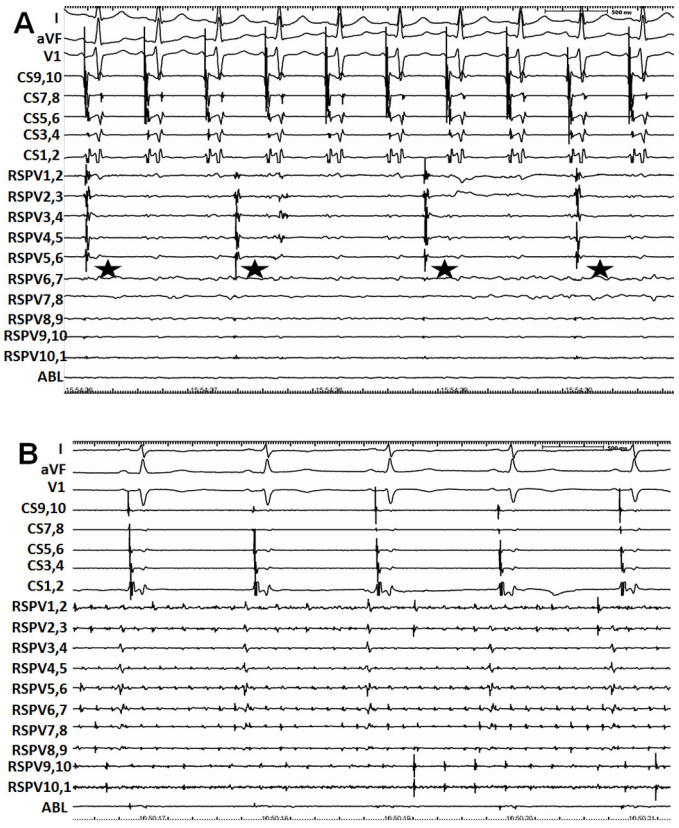

Fig. 1. Identification of spontaneous activities (dissociated pulmonary vein potentials; DPVPs). Tracings were obtained using surface electrocardiographic (ECG) leads I, aVF, V1. Intracardiac electrograms were recorded using a coronary sinus catheter (CS1,2 to CS9,10), a Lasso catheter within the right superior pulmonary vein (RSPV1,2 to RSPV10,1), and the distal pair electrodes of an ablation catheter (ABL). DPVPs were defined as sharp and high-frequency potentials that were not associated with far-field atrial potentials or catheter manipulation. Panel A: Repetitive DPVPs (★) from the RSPV were recorded after circumferential pulmonary vein isolation in a patient. Panel B: Sustained fibrillatory activities were documented from the RSPV after circumferential pulmonary vein isolation in another patient.

Fig. 2. Illustration of pulmonary vein (PV) reconnection in a patient with spontaneous activities (dissociated pulmonary vein potentials; DPVPs) in the PVs. Tracings were obtained using surface electrocardiographic leads I, aVF, V1. Intracardiac electrograms were recorded using a coronary sinus catheter (CS1,2 to CS9,10), a Lasso catheter within the left superior PV (LSPV1,2 to LSPV10,1) and the distal pair of electrodes of an ablation catheter (ABL). Repetitive DPVPs (★) were recorded from the LSPV after circumferential PV isolation in a patient. Interestingly, during the 30-min observation period, PV reconnection with the left atrium (LA) was documented as PV potentials (↑) conducted from the LA. Note that the activation sequence of the DPVPs was different from that of the PV potentials conducted from the LA.