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Original Article

# Prophylactic catheter ablation of ventricular tachycardia before cardioverter-defibrillator implantation in patients with non-ischemic cardiomyopathy: Clinical outcomes after a single endocardial ablation

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ABSTRACT

*Background:* Outcomes related to prophylactic catheter ablation (PCA) for ventricular tachycardia (VT) before implantable cardioverter-defibrillator (ICD) implantation in non-ischemic cardiomyopathy (NICM) are not well characterized. We assessed the efficacy of single endocardial PCA in NICM patients.

*Methods:* We retrospectively analyzed 101 consecutive NICM patients with sustained VT. We compared clinical outcomes of patients who underwent PCA (ABL group) with those who did not (No ABL group). Successful PCA was defined as no inducible clinical VT. We also compared the clinical outcomes of patients with successful PCA (PCA success group) with those of the No ABL group. Endpoints were appropriate ICD therapy (shock and anti-tachycardia pacing) and the occurrence of electrical storm (ES).

*Results:* PCA was performed in 42 patients, and it succeeded in 20. The time to ES occurrence was significantly longer in the ABL group than in the No ABL group ($p=0.04$). The time to first appropriate ICD therapy and ES occurrence were significantly longer in the PCA success group than in the No ABL group ($p=0.02$ and $p<0.01$, respectively).

*Conclusion:* Single endocardial PCA can decrease ES occurrence in NICM patients. However, high rates of VT recurrence and low success rates are issues to be resolved; therefore, the efficacy of single endocardial PCA is currently limited.



## 1. Introduction

The use of implantable cardioverter-defibrillators (ICDs) is the gold standard for primary and secondary prevention of sudden cardiac death [1,2]. However, shocks increase the risk of all-cause mortality, even if the shocks are inappropriate [3]. Recent studies have reported the efficacy of prophylactic catheter ablation (PCA) before ICD implantation in patients with ventricular tachycardia (VT) and ischemic cardiomyopathy [4–6]. Some studies report the efficacy of catheter ablation with a combination endocardial and epicardial approach in patients with non-ischemic cardiomyopathy (NICM) [7,8]. However, the role of PCA before ICD implantation in NICM patients has not been well described. Results from the few published studies on the subject vary, but no prospective studies have compared clinical outcomes of patients with or without prophylactic endocardial catheter ablation before cardioverter-defibrillator implantation.

Therefore, this study aimed to compare clinical outcomes of NICM patients with or without prophylactic endocardial catheter ablation. Specifically, we investigated the effect of single endocardial PCA on the reduction of appropriate ICD therapy and electrical storm (ES).

*Abbreviations:* VT, ventricular tachycardia; ICM, ischemic cardiomyopathy; NICM, non-ischemic cardiomyopathy; ICD, implantable cardioverter-defibrillator; ES, electrical storm; PCA, prophylactic catheter ablation

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## 2. Material and methods

### 2.1. Study population

This retrospective analysis included 101 consecutive patients with sustained VT and NICM who received cardioverter-defibrillator implantation at either the Hospital of Kobe University or the Hyogo Brain and Heart Center between January 2005 and May 2012. NICM included such non-ischemic diseases as idiopathic dilated cardiomyopathy (DCM), hypertrophic cardiomyopathy, arrhythmogenic right ventricular cardiomyopathy (ARVC), cardiac sarcoidosis, valvular heart disease, congenital heart disease, and others. Patients with polymorphic VT or ventricular fibrillation (VF) were excluded. Patient selection for PCA was based on the physician's discretion, but was primarily chosen for patients with several sustained episodes of VT admitted in the later years of the study, when it became a widely accepted therapy. Oral beta-blockers and/or amiodarone or sotalol were the primary drugs for chronic management after cardioverter-defibrillator implantation.

### 2.2. Electrophysiological study and VT ablation

All patients who underwent catheter ablation provided written informed consent for electrophysiological study and catheter ablation. Methods for mapping and ablation were identical to those reported previously [9–11]. Standard multielectrode catheters were placed in the high right atrium, His-bundle region, coronary sinus, and right ventricular apex.

Left and/or right ventricular mapping was performed using a 4-mm and/or 8-mm non-irrigated tip or a 3.5-mm irrigated tip ablation catheter. Initial mapping was performed using the CARTO system (Biosense Webster, Diamond Bar, CA, USA) or the EnSite system (EnSite 3000 with Precision Software, Endocardial Solutions, Inc., St. Paul, MN, USA) during sinus rhythm or right ventricular pacing. A 3-dimensional voltage map of the left ventricle (LV) and/or right ventricle (RV) was obtained. An area with low amplitude ( $< 1.5$ mV) and fractionated or late potential was considered an abnormal substrate. Dense scar was identified when no local capture on bipolar pacing was observed at 9.9 V and 2-ms pulse width. Pace mapping was used to identify the critical components of the VT circuit [11].

A programmed stimulation protocol (S1: 600 and 400 ms, with up to 2 extra stimuli with a minimum 200-ms interval) from the 2 sites (i.e., right/left ventricular apex and right ventricular outflow tract) was performed to induce clinical VT.

Simultaneous recordings of ventricular electrograms (bandpass filtered 30–500 Hz) and 12-lead surface electrocardiograms (ECGs) were stored digitally (Prucka Cardiolab, GE Medical Systems, Milwaukee, WI, USA; Bard LabSystem PRO EP Recording System, C. R. Bard, Inc. Lowell, MA, USA).

When hemodynamically tolerated VT was induced, VT activation mapping was performed in the CARTO or EnSite system, and radiofrequency (RF) current was applied at the central to exit zones of the circuit as identified using entrainment pacing during VT [12,13]. If hemodynamically unstable VT was induced, substrate-based ablation was performed. RF ablation lesions were created within the region identified to be critical for sustaining clinical VT based on substrate mapping [11]. In cases in which we could not detect an abnormal substrate, RF current was applied at the earliest activation site of induced VT or at the exit zone detected on pace mapping.

The standard ablation setting of a non-irrigation catheter consisted of a tip temperature of 60 °C and 30–40 W power for 4-mm tips or 40–50 W for 8-mm tips. When an irrigation catheter was employed, a catheter tip temperature of 43 °C, a 35 W power, and a 30 mL/min flow rate were used.

At the end of the ablation procedure, VT induction was performed with up to double extra stimuli and rapid pacing (minimum pacing cycle at 240 ms, 15 beats) from the 2 sites. Patients without induced VT were classified to the "No VT" group and patients without induced clinical VT (documented on a 12-lead ECG before ablation) were classified to the "No clinical VT" group. In this study, the successful ablation (PCA success) group was composed of the "No VT" and the "No clinical VT" groups. Patients in whom clinical VT was induced at the end of the procedure were classified to the "PCA failure" group.

### 2.3. Implantation of the cardioverter-defibrillator

Implantation of the cardioverter-defibrillator was performed for all 101 patients. Patients in the ABL group received cardioverter-defibrillator implantation after catheter ablation. The device programming consisted of a VF zone with a cut-off rate of 200–220 beats per minute and a VT zone with a cut-off cycle length of at least 40 ms above the cycle length of documented VT and anti-tachycardia pacing (ATP) followed by shock therapy.

### 2.4. Follow-up

Patients were evaluated in outpatient clinics at 3-month intervals. Analysis of VT recurrence depended on clearly differentiating VT/VF events from supraventricular tachycardia events. For reliably identifying VT, ICD diagnosis was confirmed by two or more physicians examining stored electrograms. VT recurrence was defined as appropriate ICD therapy, including shock and ATP. ES was defined as $\geq 3$ separate episodes of ventricular arrhythmia during a 24-h period. Drug management during follow-up was used at each physician's discretion.

### 2.5. Statistical analysis

Continuous variables are expressed as mean $\pm$ standard deviation; they were compared using two-sample *t*-tests. Categorical variables were compared using the chi-squared test. Time-to-event curves describing event-free survival of patients during follow-up were calculated using the Kaplan–Meier method and compared using the log-rank test. Statistical analyses were performed using the SPSS statistical software program (version 20.0, SPSS, Inc., Chicago, IL, USA). A two-sided $p < 0.05$ was considered statistically significant.

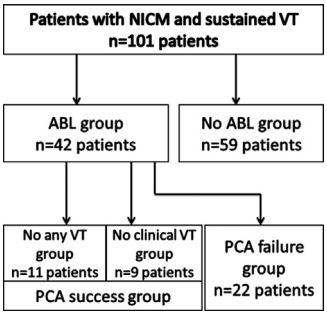


**Fig. 1.** Patient classification. Prophylactic catheter ablation (PCA) was performed in 42 of 101 patients, classified as the ABL group. The remaining 59 patients were classified as the No ABL group. Patients with no induced VT were classified as the "No VT" group and patients with no induced clinical VT were classified as the "No clinical VT" group. These two groups comprised the PCA success group. Patients in which clinical VT was induced at the end of procedure were classified to the "PCA failure" group.