Second coupling interval of nonsustained ventricular tachycardia to distinguish malignant from benign outflow tract ventricular tachycardias

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BACKGROUND Idiopathic ventricular tachycardia (VT) originating from the outflow tract (OT) usually is considered a benign condition. In rare cases, patients with OT-VT suffer from syncope or even sudden cardiac death. OT-VT is frequently preceded by nonsustained VT (NSVT).

OBJECTIVE The purpose of this study was to clarify if the ECG parameters of NSVTs could differentiate malignant from benign OT-VT.

METHODS We retrospectively evaluated patients without structural heart disease who had documented OT-NSVT on ECG. ECG parameters were compared between patients with syncope, aborted sudden cardiac death, or ventricular fibrillation (malignant group, n = 36) and patients without syncope (benign group, n = 40).

RESULTS There were no differences with regard to age and gender between the malignant and benign groups. On analysis of NSVT, the first coupling interval (CI) of NSVT was comparable between the 2 groups (458 ± 87 ms vs 485 ± 95 ms, $P = .212$). However, the second CI of NSVT beats was significantly shorter in the malignant group (313 ± 58 ms vs 385 ± 83 ms, $P < .0001$). During 48-month follow-up, the benign group had a significantly lower recurrence of clinical VT than the malignant group ($P = .046$). The malignant group frequently had more than 1 focus of VT, whereas the benign group showed only a single focus (1.82 vs 1.09, $P = .023$).

CONCLUSION The second CI of NSVT in the malignant group was significantly shorter than that of the benign OT-VT group. Careful measurement of the second CI of NSVT may help identify the malignant form of OT-VT, enabling early treatment to prevent future cardiac events.

KEYWORDS Outflow tract; Ventricular tachycardia; Electrocardiography

ABBREVIATIONS **CI** = coupling interval; **EPS** = electrophysiologic study; **ICD** = implantable cardioverter-defibrillator; **NSVT** = nonsustained ventricular tachycardia; **OT** = outflow tract; **PI** = prematurity index; **PVC** = premature ventricular contraction; **PVT** = polymorphic ventricular tachycardia; **RFCA** = radiofrequency catheter ablation; **RVOT** = right ventricular outflow tract; **SCD** = sudden cardiac death; **TCL** = tachycardia cycle length; **VF** = ventricular fibrillation; **VT** = ventricular tachycardia

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Introduction

Ventricular tachycardia (VT) and premature ventricular contraction (PVC) originating from the outflow tract (OT) in patients without structural heart disease usually shows a monomorphic pattern and is considered a benign condition.[1] However, some patients suffer from syncope or even sudden cardiac death (SCD) due to hemodynamically unstable, fatal VT, or ventricular fibrillation (VF).[2] Previous studies have determined that catheter ablation of malignant VT or idiopathic VF, targeting the triggering PVC, may be effective in preventing recurrence of clinical events.[3,4] Distinguishing malignant from benign VT originating from the OT is essential because proper management can prevent unexpected cardiac events. Several differences in ECG characteristics have been reported between malignant and benign forms of idiopathic VT.[2,3,5–7] Previous reports have suggested that a relatively short coupling interval (CI) of the initiating PVC results in polymorphic malignant VT or VF.[3,5] The average QRS duration of the initiating PVCs is reported to be slightly longer in malignant than in benign OT-VT.[2,3] In addition, a significant difference was seen in the tachycardia cycle length (TCL) of VT between malignant and benign OT-VT.[2] However, these ECG trends are not consistent among studies and cannot be clinically applied because of considerable overlap of ECG parameter values and undefined cutoffs.

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OT-VT frequently presents as nonsustained ventricular tachycardia (NSVT). In some cases with serious clinical events, the only documented tachycardia episodes are NSVT. Even patients with idiopathic VF often initially present with NSVT. Therefore, it is clinically important to analyze the characteristics of NSVT preceding sustained VT. The aim of this study was to clarify the ECG parameters of such cases of NSVT to differentiate malignant from benign OT-VT.

Methods

Study population

We retrospectively assessed 170 patients with ventricular tachyarrhythmia originating from the OT area who underwent radiofrequency catheter ablation (RFCA) or placement of an implantable cardioverter-defibrillator (ICD) between December 2001 and January 2014. Patients with Brugada syndrome, early repolarization syndrome, arrhythmogenic right ventricular cardiomyopathy, or long QT syndrome were excluded. Six patients who had structural heart diseases on echocardiography or magnetic resonance imaging also were excluded (Figure 1). Therefore, 155 patients without structural heart diseases were assessed in our analysis. Among these patients, 51 had only PVC/NSVT and 28 had only sustained VT. We evaluated 76 patients who had both sustained VT and NSVT. The malignant group was defined as patients with syncope or aborted SCD. Based on these definitions, 36 patients were classified into the malignant group, and 40 patients with monomorphic VT without syncope were categorized into the benign group. All patients in the malignant group lacked prodromal symptoms suggestive of vasovagal syncope. Tilt-table tests were performed on 28 patients and all were negative. The study was approved by our institutional ethics committee.

ECG analysis

NSVT was defined as VT lasting <30 seconds. During normal sinus rhythm, R-R intervals and corrected QT intervals were evaluated. In sustained VT, we measured the tachycardia cycle length (TCL), which was defined as the average R-R interval during VT. During NSVT, we measured (1) the CI and QRS duration of the first, second, and third NSVT beats, at which points the QRS complex morphology was identical to that of the sustained VT. We also evaluated (2) the CI and QRS duration of the isolated PVC (Figure 2A). For further detailed analysis of the ECG characteristics, the following ECG parameters also were assessed: (3) the prematurity index (PI), defined as the ratio of the CI of the first NSVT beat or isolated PVC to the preceding R-R interval of the sinus cycle just before the NSVT or isolated PVC; and (4) the QT index, defined as the ratio of the CI of the first NSVT beat or isolated PVC to the QT interval of the preceding sinus complex (Figure 2B).[6,8] In the case of multiple episodes of NSVT, we calculated the average $\pm$ SD of the CIs, and the average value for that patient in particular was used (see Online Supplemental Figure 1). The resolution of all measurements of ECG parameters was at least 20 ms with a paper speed of 25 mm/s, calibration of 10 mm/mV, and low-pass filter of 40 Hz.

Results of catheter ablation and clinical follow-up

A successful ablation was defined as (1) elimination of VT and PVCs or (2) noninducible clinical VT/PVCs with and/or without infusion of isoproterenol and phenylephrine at the end of the procedure. Partial success was defined as elimination of clinical VT with residual isolated PVCs from the target origin. A failed ablation was defined as the inability to suppress VT and/or the recurrence of clinical arrhythmia in the absence of any antiarrhythmic drugs.[9,10] Patients who failed catheter ablation for the focus of VT or documented VF received an ICD and/or maintained oral medication to prevent any future SCD.

Long-term outcomes were considered recurrent clinical VT/VF requiring additional procedures. Additional medications during the follow-up period and/or an appropriate therapy from ICD also were analyzed.

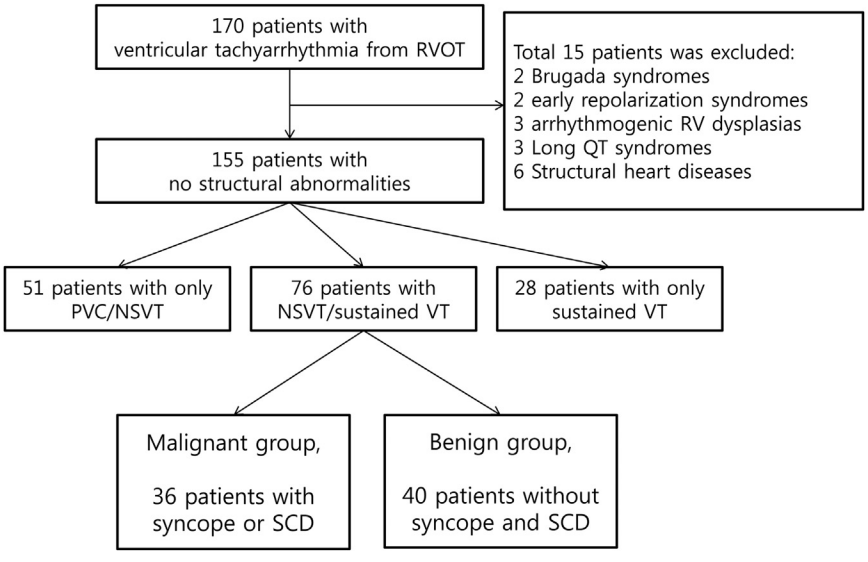

Figure 1 Study enrollment. Flow diagram of the patients included in the study. Boxes list numbers of patients included at each stage. NSVT = nonsustained ventricular tachycardia; PVC = premature ventricular contraction; RV = right ventricle; RVOT = right ventricular outflow tract; SCD = sudden cardiac death.