Different characteristics and electrophysiological properties between early and late recurrences after acute successful catheter ablation of idiopathic right ventricular outflow tract arrhythmias during long-term follow-up

Fa-Po Chung, MD,[*] Eric Chong, MBBS, MRCP, FAMS, FESC,[*†] Yenn-Jiang Lin, MD,[*‡] Shih-Lin Chang, MD,[*‡] Li-Wei Lo, MD,[*‡] Yu-Feng Hu, MD,[*‡] Ta-Chuan Tuan, MD,[*‡] Tze-Fan Chao, MD,[*‡] Jo-Nan Liao, MD,[*] Yen-Chang Huang, MD,[§] Po-Ching Chi, MD,[‖] Chao-Shun Chan, MD,[¶] Yun-Yu Chen, MPH,[*#] Hung-Kai Huang, MD,[**] Shih-Ann Chen, MD[*‡]

From the [*]Division of Cardiology, Department of Medicine, Taipei Veterans General Hospital, Taipei City, Taiwan, [†]Department of Cardiology, National University Hospital, Singapore, [‡]Institute of Clinical Medicine and Cardiovascular Research Center, National Yang-Ming University, Taipei, Taiwan, [§]Department of Medicine, Taipei City Hospital, Taipei, Taiwan, [‖]Department of Cardiology, Mackay Memorial Hospital, Taipei, Taiwan, [¶]Division of Cardiology, Department of Medicine, Taipei Medical University Hospital, Taipei, Taiwan, [#]Institute of Epidemiology and Preventive Medicine College of Public Health, National Taiwan University, Taipei, Taiwan, and [**]Department of Medicine, Chang-Hua Christian Hospital, Taipei, Taiwan.

BACKGROUND Radiofrequency catheter ablation (RFCA) is an effective therapeutic strategy in eliminating drug-refractory idiopathic right ventricular outflow tract ventricular arrhythmias (RVOT VAs). It remains unclear what factors affect early and late VA recurrences after ablation.

OBJECTIVE The aim of our study was to elucidate the differences between early and late recurrences after acute successful RFCA of RVOT VAs in a long-term follow-up.

METHODS A total of 220 patients with acute successful RFCA of RVOT VAs were enrolled. Detailed clinical characteristics and assessments by noninvasive and invasive electrophysiology study were explored to predict the overall, early ($\leq$1 year), and late VA ($>$1 year) recurrences.

RESULTS During a mean follow-up of 34.15 $\pm$ 33.74 months, 45 of 220 patients (20.5%) documented recurrence of RVOT VAs after the initial RFCA. Of these patients, 26 patients (57.8%) with recurrent VAs showed similar morphology, and 19 (42.2%) were different. Patients with recurrent VAs were associated with a higher incidence of hypertension, higher systolic blood pressure, identification of foci by pace mapping alone, shorter earliest activation time, more radiofrequency pulses required, and VA originating from the anterior free wall. Multivariate analysis demonstrated that mapping strategy and shorter earliest activation time preceding VA were associated with early recurrences (hazard ratio [HR] 2.26; 95% confidence interval [CI] 1.49–3.42; $P < .001$; and HR 0.91; 95% CI 0.85–0.98; $P = .008$, respectively), whereas hypertension was associated with late recurrence (HR 3.48; 95% CI 1.34–9.07; $P = .001$).

CONCLUSION RFCA is an effective strategy in the elimination of RVOT VAs. However, early and late recurrences occur commonly. Patients with early and late VA recurrences demonstrated nonuniform patterns of clinical characteristics and electrophysiological properties.

KEYWORDS Early recurrence; Late recurrence; Radiofrequency catheter ablation; Right ventricular outflow tract; Ventricular arrhythmias

ABBREVIATIONS **BP** = blood pressure; **CI** = confidence interval; **ECG** = electrocardiography/electrocardiogram; **HR** = hazard ratio; **PVC** = premature ventricular complex; **RFCA** = radiofrequency

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catheter ablation; **RVOT** = right ventricular outflow tract; **VA** = ventricular arrhythmia; **VT** = ventricular tachycardia

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Introduction

Idiopathic ventricular arrhythmias (VAs) commonly originate from the right ventricular outflow tract (RVOT) in structurally normal hearts, which are typically characterized by electrocardiographic features of left bundle branch block morphology and inferior axis.[1,2] The manifestation of RVOT VAs can vary from the presence of frequent premature ventricular complexes (PVCs) to repetitive salvos, nonsustained ventricular tachycardia (VT) and incessant VTs,[3] which could lead to various clinical symptoms including palpitation, dyspnea, atypical chest pain, and syncope.[4] Although idiopathic RVOT VA is usually considered as a "benign" entity, it has been linked to the development of PVC-associated cardiomyopathy.[5] Furthermore, trigger originating from the RVOT with a short coupling interval carry the risk of initiating ventricular fibrillation and polymorphic VT.[6]

Antiarrhythmic drugs therapy has played an important role in the initial management of RVOT VAs. Radiofrequency catheter ablation (RFCA) of arrhythmogenic foci in the RVOT provides an alternative and potentially curative therapy for drug-refractory cases.[7–9] With rapid advancement of mapping and ablation technology, acute procedural success rate for RVOT VA ablation can be achieved in 80%–90% of the cases. However, a variable recurrence rate has been reported and several predictors have been proposed for procedural failure and VA recurrence.[8–10] Despite the fact that most recurrences occur within the first year,[11] Ventura et al[12] reported that 52% of the patients developed recurrence after acute successful ablation during decennial follow-up and late recurrences after 1 year of ablation were not uncommon. It remains unknown whether clinical characteristics and electrophysiological properties in patients with late recurrences of RVOT VAs are similar as those with early recurrences.

Thus, the purpose of our study was to elucidate the characteristics and electrophysiological properties of RVOT VAs in patients who developed early and late recurrences after acute successful RFCA during long-term follow-up. We also compared the different characteristics between patients with early recurrences and those with late recurrences.

Methods

Patient selection

From 1999 to 2013, consecutive patients referred to our center for drug refractory idiopathic RVOT VAs with electrocardiographic features of typical left bundle branch block and inferior axis QRS morphology who underwent an electrophysiology study and RFCA were recruited. Baseline characteristics were assessed in detail. The heart was evaluated via echocardiography and/or magnetic resonance imaging heart study before RFCA to exclude the possibility of structural heart disease. Free from antiarrhythmic drugs, the manifestation in patients with RVOT VAs was assessed by using electrocardiography and 24-hour Holter monitoring before ablation. Patients with Brugada ECG pattern involving anterior precordial leads or received the diagnosis of Brugada syndrome were also excluded. The density of VA was measured, and the types of VAs were further categorized into symptomatic PVC ($>20\%$), nonsustained VT (<30 seconds), and sustained VT. Patients who received antiarrhythmic drug therapy after RFCA were excluded from further analysis.

Electrophysiology study, mapping, and RFCA

After obtaining informed consent from patients, we performed a standardized electrophysiology study for all patients in the fasting state without sedation. Antiarrhythmic drugs were discontinued for a minimum of 5 half-lives before RFCA (except amiodarone). In the absence of spontaneous VA, rapid ventricular pacing and programmed stimulation up to 3 extrastimuli were performed with catheter placed at the right ventricular apex and RVOT sequentially. If VA was still not inducible, intravenous isoprenaline (1–5 μg/min) was infused to achieve at least 20% heart rate increment. If spontaneous VAs were not inducible during pharmacological provocation, the induction protocol was repeated. The QRS morphologies of spontaneous and/or induced VAs were compared with those of the documented VAs.

The localization of arrhythmogenic foci was performed conventionally or by using 3D mapping system (Ensite NavX, St Jude Medical, Inc, St Paul, MN, or CARTO 3, Biosense Webster, Diamond Bar, CA). Activation mapping, defining the earliest local electrical signals, and/or pace mapping by comparing the 12-lead QRS morphology of paced PVCs with clinical PVCs aiming for at least 11 of 12 leads matching were performed. The target ablation site was selected on the basis of the earliest activation site and/or site of the optimal pace mapping. Radiofrequency energy was delivered in a temperature-controlled mode at 50ºC with pulse duration of 60 seconds; maximal power was 50 W for the nonirrigated catheter and 30–35 W for the irrigated catheter, targeting for an impedance decrease of 10 Ω. If the VA was suppressed within 30 seconds, radiofrequency energy would be maintained for a total of 60 seconds and additional energy would be applied up to a maximum of 5 ablation lesions. Repeat mapping was performed if VA suppression and/or elimination was not observed. Acute procedural success was defined as the complete elimination of spontaneous or inducible VAs under the infusion of isoprenaline, following the same induction protocol for 30 minutes to exclude acute recurrences. The arrhythmogenic focus was localized by the acute successful site of RFCA, and the location was categorized into anterior medial wall, anterior free wall, posterior medial wall, and posterior free wall of the RVOT depending on the navigation system (if available), or fluoroscopic images in