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Risk factor algorithm used to predict frequent premature ventricular contraction-induced cardiomyopathy

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ABSTRACT

Background: Premature ventricular contraction (PVC) QRS duration (QRSd) and high PVCs burden are known as a risk factor of PVC-induced cardiomyopathy (CMP). The aim of this study is to find useful algorithm to predict PVC-induced CMP.
Methods: 180 patients (99 males, 51 ± 14 years) with frequent PVCs (>10%/24 h), who underwent successful PVC ablation, were studied. Typical PVC-related symptoms were defined as the presence of palpitations or dropped beats during PVC. Group A ($n = 144$) was symptomatic and Group B ($n = 36$) was asymptomatic.
Results: The incidence of CMP was significantly higher in group B (group A = 19%, group B = 66%, $p < 0.001$). In group A, there were significant differences, between the patients with normal EF and CMP, in terms of sex ($p = 0.005$), daily PVC burden ($p = 0.012$), distribution of PVCs with a LV site ($p < 0.009$), and PVC QRSd ($p < 0.001$). In group B, the PVC QRSd was significantly wider in patients with CMP. Multivariate analysis showed that PVC QRSd ($p < 0.001$), PVC burden ($p = 0.022$), and LV site ($p = 0.043$) were risk factors for CMP.
Conclusions: Using our scoring algorithm for this patient sample, we are able to predict the development of PVC-induced CMP with 80% sensitivity, 81% specificity, 64% positive predictive value, and 91% negative predictive value.

1. Introduction

Idiopathic premature ventricular contractions (PVC) are one of the most common arrhythmias in the world, with most patients complaining of PVC-associated symptoms. However, some patients are asymptomatic, even with a high burden of PVCs. Despite this arrhythmia's commonality, our understanding of the significance of the symptoms remains limited.

According to a study by Hasdemir C. et al., asymptomatic patients are more often diagnosed with cardiomyopathy (CMP) than symptomatic patients, and palpitations are the most frequent symptom in PVC patients with a normal left ventricular ejection fraction (LVEF) [1]. Additionally, the work of Yokokawa et al. revealed that the duration of palpitations and the absence of symptoms are independently associated with PVC-induced CMP [2]. Recently, Park K.M. et al. also suggested that the absence of typical PVC-related symptoms may be a risk factor for CMP, and the absence of symptoms is associated with adverse outcomes [3]. Several reports have described an association of PVC-induced CMP with a PVC frequency >20% [4–9]. In addition, a recent study by Carballeira P. et al. reported that PVC QRS duration is also a marker of risk for the development of PVC-induced CMP [10,11]. Based on the above studies, we suggest that different mechanism may exist to cause PVC-induced CMP according to the presence or absence of symptoms in the development of PVC-induced CMP. In this study, we explored a risk factors algorithm for the prediction of PVC-induced CMP according to the presence of PVC-related symptoms by analyzing clinical and electrocardiographic (ECG) parameters.

2. Methods

2.1. Study population

We retrospectively reviewed the medical records of 801 patients with frequent PVCs who visited outpatient clinics at Samsung Medical Center from January 2000 to December 2014. The ethics committee of Samsung Medical Center approved the research protocol, and Informed consent was obtained from each patient and the study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki as reflected in a priori approval by the institution's human research committee [12].

Inclusion criteria for this study were as follows: frequent PVCs (>10% PVCs per 24 h) on two episodes of Holter monitoring spaced by at least one week, Holter monitoring with no evidence of additional atrial or ventricular tachyarrhythmias, the presence of detailed

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[1] This author takes responsibility for all aspects of the reliability and freedom from bias of the data presented and their discussed interpretation.
[2] This author performed preliminary analyses.

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clinical symptom descriptions in the medical records, the presence of baseline and follow-up ECGs, and the presence of transthoracic echocardiography (TTE) studies. The patient with normal LVEF was defined by a global LVEF ≥50% at baseline and follow-up. PVC-induced CMP was defined by a global LVEF <50% before PVC suppression and by normalization of the LVEF (≥50% and improvement by ≥10% points) after successful PVC suppression with either radiofrequency ablation. Acute success was defined as no clinical VPDs after a ≥30-minute waiting period after ablation or after a 1-week waiting period after RFCA. Long-term success was defined as ≥80% reduction in VPD burden on regular post-ablation Holter monitoring [13]. If the patients did not undergo successful ablation of PVCs, we conclude that their PVC origin (RV or LV) based upon morphologic criteria [14]. And Subjects were excluded based on any of the following criteria: 1) a history of atrial fibrillation, atrial flutter, atrial tachycardia, non-sustained ventricular tachycardia (NSVT), sustained VT, or evidence of any of these arrhythmias by ECG or Holter monitoring, and 2) a history of myocardial infarction, structural heart disease, or heart valve replacement/repair based on information obtained from TTE, radionuclide evaluation, or cardiac catheterization.

A cardiologist evaluated all PVC-related symptoms reported in the medical records. Patients who felt palpitations during the PVCs, including dropped or skipped beats, were categorized as symptomatic (group A, typical PVC-related symptoms). Patients who did not feel any palpitations or dropped beats during PVCs or who felt atypical PVC symptoms were categorized as asymptomatic (group B). Fatigue, dizziness, syncope, and shortness of breath were considered atypical PVC symptoms. Additionally, 24-hour Holter monitoring was evaluated in detail to determine the correlation between PVCs and typical PVC-related symptoms. All asymptomatic patients were diagnosed with frequent PVCs during regular ECG check-ups or before non-cardiac procedures. These patients were referred to our institution for further management of their PVCs.

2.2. Holter monitoring

Before treatment, Holter monitoring was performed twice monthly at intervals of at least one week to measure the mean PVC burden (proportion and number of PVCs per day). Follow-up Holter monitoring was repeated twice at intervals of at least one week within six months of treatment by RFCA. Thereafter, Holter monitoring was performed at intervals of three to six months or if PVC-related symptoms recurred.

2.3. Electrocardiography measurements

The initial ECG was recorded at a sweep speed of 100 ms and subsequently analyzed offline with a Muse® Cardiology Information System using digital calipers. Sinus QRS and PVC QRS were evaluated with respect to the QRS duration (QRSd).

- Sinus cycle length (ms): from peak R wave to peak R wave between sinus beats
- PVC QRSd (ms): from the onset of the PVC to the terminal S wave
- PVC coupling interval (CI, ms): from the onset of the R wave of the preceding sinus beat to the onset of the PVC
- Post-PVC CI (ms): from the onset of the PVC to initiation of the next sinus beat

One of two authors (KMP or KJC), who were blinded to the echocardiographic outcomes, performed all ECG measurements. Inter-observer agreement for these measurements was performed on a subset of 20 ECG measurements. All ECG measurements were repeated on two separate PVCs occurring prior to PVC suppression. The mean of the two measurements was analyzed and used to minimize measurement error. In the case of multiple PVC morphologies, the dominant or targeted PVC was measured.

2.4. Prospective analysis

We then performed a prospective evaluation of a second cohort of consecutive patients with frequent PVC who met the same inclusion criteria used in the retrospective cohort and who presented for catheter ablation between January 2015 and July 2015.

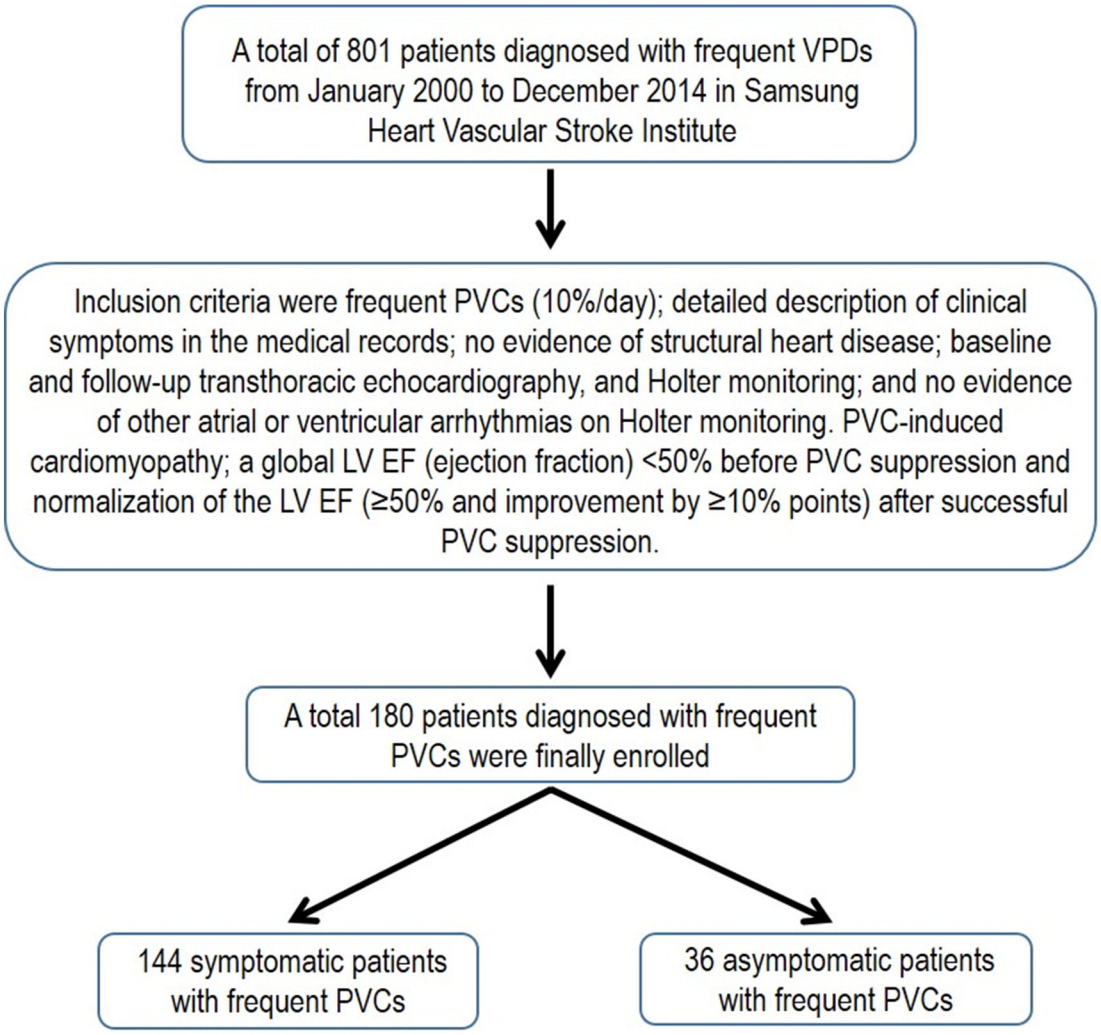

Fig. 1. Study scheme: Inclusion criteria of this study. PVC = premature ventricular contraction; LV = left ventricle.

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