Premature Ventricular Contraction-Induced Cardiomyopathy

Kyoung-Min Park, MD PhD
Samsung Medical Center, Electrophysiology Program
kyoungmin.park@samsung.com
Some light on the subject

- Observational studies in healthy subjects - 1970s to 1990s
  - ~10% of subjects will have “frequent” PVCs (>100/24h or 0.1% PVCs)
  - >1% PVCs is rare
  - Athletes tend to have a higher rate of PVCs

Generally a good prognosis

Biffi A et al. JACC. 2002; 40(3): 446.
Are all PVCs benign?
PVC & Symptom
Symptoms caused by PVCs

- Palpitations/skipped beats
- Dizziness
- Fatigue
- Dyspnea - at rest or on exertion
- Asymptomatic
Infrequent PVCs - skipped beats

PVC usually not felt

Forceful beat after pause
PVC

HF Symptoms - dizziness, fatigue, dyspnea...

Bradycardia - non perfused PVC
Asymptomatic PVC

- lack of palpitation is an independent factor prone to developing PVC-induced cardiomyopathy


- PVC burden in asymptomatic patients was significantly higher than symptomatic patients


- It is very reasonable to consider ablating all PVCs, regardless of their origin or associated symptoms when improvement of cardiac function is sought


- the absence of typical PVC-related symptoms may be a risk factor for cardiomyopathy and be associated with an adverse outcome.

PVC burden
What about frequent PVCs?

Concealed Mechanical Bradycardia
(Electro-mechanical dissociation/pulseless electrical activity)
Deleterious effects of frequent PVCs

- Frequent dysynchronous LV contraction
- Reversed rotational LV squeezing
- Chronic preload strain due to relative bradycardia
- Depletion of myocardial energy storage
- Abnormal calcium handling
- Myocardial ischemia (endo/epi flow mismatch)
Normal LV function + frequent PVCs

- Longitudinal study of 281 patients with frequent, asymptomatic outflow tract PVCs in Japan:

>10-20% PVCs may be bad in the long-term

PVC-induced cardiomyopathy

Frequent PVCs

LV dilation and dysfunction

Reversible with elimination of the PVC

Olgun H et al. Heart Rhythm 2011;8:1046–1049
Baman TS et al. Heart Rhythm 2010;7:865–869
Simantirakis EN et al. Europace 2012;14:466–473
Tachycardia-Induced Cardiomyopathy in Patients With Idiopathic Ventricular Arrhythmias: The Incidence, Clinical and Electrophysiologic Characteristics, and the Predictors

- PVC burden > 16% (Sensitivity 100%, Specificity 87%, AUC 0.96)

Electrocardiographic and electrophysiological characteristics of premature ventricular complexes associated with left ventricular dysfunction in patients without structural heart disease

PVC burden > 26%
(Sensitivity 70%, Specificity 78%)

Normal LV function + frequent PVCs

Is there a dose response relationship?


(Sensitivity 79%, Specificity 78%, AUC 0.89)
Cardiovascular health study

N=1139, normal LVEF, no history of CHF

mean follow-up period: 13.7 yrs

Other factors & Cardiomyopathy ?
### PVC QRS duration

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Study first author (Year)</th>
<th>Study design and population</th>
<th>Study findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVC QRS duration</td>
<td>Yokokawa [2012] [12]</td>
<td>Retrospective study</td>
<td>PVC QRS duration significantly greater in irreversible PVC-induced cardiomyopathy compared with reversible (164 ± 20 ms vs. 149 ± 17 ms; P &lt; 0.0001)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Epicardial PVCs: widest QRS complexes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>294 patients with frequent PVCs and impaired LVEF referred for ablation</td>
<td></td>
</tr>
<tr>
<td>Carballeira (2014) [13*]</td>
<td>Retrospective study</td>
<td></td>
<td>PVC QRS ≥150 ms to differentiate patients with and without reversible PVC-induced cardiomyopathy</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>PVC QRS ≥150 ms require a lower PVC burden for developing cardiomyopathy (22 ± 13% vs. 28 ± 12%; P &lt; 0.0001)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Of 45 patients, with a PVC burden of ≥10%, 38% developed PVC-induced cardiomyopathy</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>PVC burden similar, but those with LV dysfunction had wider PVC QRS (159 ms vs. 142 ms; P &lt; 0.001)</td>
</tr>
</tbody>
</table>

* Deyell MW et al. Heart Rhythm 2012;9:1465-72
  * Park KM et al. Int J Cardiol 2017;233:37-42
- **Coupling Interval**

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Study first author (Year)</th>
<th>Study design and population</th>
<th>Study findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVC coupling interval</td>
<td>Del Carpio Munoz (2011) [14]</td>
<td>Retrospective study</td>
<td>No significant difference in the PVC coupling interval between those with reduced LVEF and those with normal LVEF in patients with frequent PVCs</td>
</tr>
<tr>
<td></td>
<td>Zhong (2014) [15$^*$]</td>
<td>Retrospective study</td>
<td>PVC coupling interval of $&lt;450\text{ms}$ was an independent predictor of LVEF normalization</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>70 patients with frequent PVCs and impaired LVEF referred for ablation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>510 patients with frequent PVCs ($&gt;1000/24\text{h}$) treated with ablation or antiarrhythmic therapy</td>
</tr>
</tbody>
</table>
Coupling Interval Dispersion and Body Mass Index Are Independent Predictors of Idiopathic Premature Ventricular Complex-Induced Cardiomyopathy

MITSUHARU KAWAMURA, M.D., NITISH BADHWAR, M.D., VASANTH VEDANTHAM, M.D., PH.D., ZIAN H. TSENG, M.D., M.A.S., BYRON K. LEE, M.D., M.A.S., RANDALL J. LEE, M.D., PH.D., GREGORY M. MARCUS, M.D., M.A.S., JEFFREY E. OLGIN, M.D., EDWARD P. GERSTENFELD, M.D., and MELVIN M. SCHEINMAN, M.D.

From the Division of Cardiology, University of California, San Francisco, California, USA

J Cardiovasc Electrophysiol, 2014;25:756-762

**Coupling interval dispersion**

\[ \text{P < 0.001} \]

<table>
<thead>
<tr>
<th>Coupling Interval Dispersion</th>
<th>Coupling Interval Dispersion</th>
</tr>
</thead>
<tbody>
<tr>
<td>(msec)</td>
<td>(msec)</td>
</tr>
<tr>
<td>[ \text{LV dysfunction} ]</td>
<td>[ \text{Normal LV} ]</td>
</tr>
</tbody>
</table>

\[ R = -0.409 \]
\[ P = 0.0001 \]
\[ N = 214 \]
### Interpolated PVCs

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Study first author (Year)</th>
<th>Study design and population</th>
<th>Study findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interpolated PVCs</td>
<td>Olgun (2011) [16]</td>
<td>Retrospective study</td>
<td>Predictive of the presence of PVC-induced cardiomyopathy</td>
</tr>
</tbody>
</table>

51 patients with frequent PVCs referred for catheter ablation; no history of CAD or MI.
Left Ventricular Dyssynchrony Predicts the Cardiomyopathy Associated With Premature Ventricular Contractions

Tomas E. Walters, MD, PhD, Dolkun Rahmutula, MD, PhD, Judit Szilagyi, MD, Christina Alhede, MD, PhD, Richard Sievers, BS, Qizhi Fang, MD, Jeffrey Olgin, MD, Edward P. Gerstenfeld, MS, MD
Risk factor algorithm used to predict frequent premature ventricular contraction-induced cardiomyopathy

Kyoung-Min Park a,1, Sung Il Im b,2, Seung-Jung Park a, June Soo Kim a, Young Keun On a,*

Typical PVC-related symptoms:
palpitation or dropped beats

- yes (group A)
  - Risk Factors Point:
    - PVC QRSd ≥ 156ms = 2.0p
    - PVC burden ≥ 26% = 1.0p
    - Male patient = 0.5p
    - LV site of origin = 0.5p
  - Total Points ≥ 2.0p
  - Cardiomyopathy

- (group B) no
  - PVC QRSd ≥ 156ms
  - YES
  - Cardiomyopathy

- Sensitivity: 80%
- Specificity: 81%
- PPV: 64%
- NPV: 91%

Cut-off 156 ms
Cut-off 26%
PVC burden: AUC = 0.76
PVC QRSd: AUC = 0.85
AADs vs RF ablation
Relative efficacy of catheter ablation vs antiarrhythmic drugs in treating premature ventricular contractions: A single-center retrospective study

Li Zhong, MD, PhD, Ying-Hsiang Lee, MD, Xin-Miao Huang, MD, PhD, Samuel J. Asivatham, MD, FHR, Win-Kuang Shen, MD, FHR, Paul A. Friedman, MD, FHR, David O. Hodge, MS, Joshua P. Slusser, BS, Zhi-Yuan Song, MD, Douglas L. Packer, MD, FHR, Yong-Mei Cha, MD, FHR

[Graphs and tables showing comparison of PVC frequency before and after treatment with different drugs and ablation procedures.]
The numerous toxicities of amiodarone
Memories of CAST

SPECIAL REPORT

PRELIMINARY REPORT: EFFECT OF ENCAINIDE AND FLECAINIDE ON MORTALITY IN A RANDOMIZED TRIAL OF ARRHYTHMIA SUPPRESSION AFTER MYOCARDIAL INFARCTION
RF ablation
PVC ablation in 2018

- Improved ECG localization of site of origin prior to ablation
- Enhanced 3D mapping catheters (Pentaray, Rhythmia, Grid)
- Intracardiac echocardiography
- Irrigated contact force catheters – better deep lesion formation

No longer reliant on anti-arrhythmics!
RFA effects in CHF setting

- Multiple studies suggest improvement in LV function post ablation
- Effect not limited to procedures with complete PVC elimination

Meta-analysis of outflow tract PVCs

Mountantonakis SE. Heart Rhythm 2011;8:1608-1614

Lamba J et al PACE 2014;37:73-78
Efficacy of ablation

- PENN experience (~100 PVC ablations/year 2008-2010)
- A large proportion of patients had a prior failed procedure

- 85-90% Success
- <1% Major Complications

Difficult sites:
- Papillary muscles
- AIV/epicardial
- Even lower with right-sided procedures
- 1/500-1/1000 chance of disability or death

60% of procedures left-sided
Summary

• Whether or not there is a symptom due to PVC is irrelevant to PVC-induced CMP

• The higher daily PVC burden, the higher is the mortality, and a risk factor of the outbreak of PVC-induced CMP

• PVC QRS duration, interpolated PVCs, CI dispersion, site of origin are also important predictors of PVC-induced CMP

• The RF ablation procedure of ventricular arrhythmia is well accepted treatment with proven efficacy and safety
Thank you!