Various Morphological Types of Ventricular Premature Beats with Fragmented QRS Waves on 12 Lead Holter ECG had a Positive Relationship with Left Ventricular Fibrosis on CT in Patients with Hypertrophic Cardiomyopathy

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DISCLOSURE INFORMATION:
The following relationships exist related to this presentation: Koya Ozawa, Nobusada Funabashi, Akihisa Kataoka, Hiroyuki Takaoka, Masae Uehara, Yoshio Kobayashi
- None of authors have relationships to disclose.
Background

• Conduction abnormalities within the QRS complex are manifested as fragmented QRS waves, which appear as multiple spikes within the QRS wave complex.

• In patients with coronary artery disease, the presence of fragmented QRS waves has been used as an indicator of non-Q-wave myocardial infarction and as a predictor of ventricular arrhythmia.

• Fragmented QRS wave is an important marker of spontaneous ventricular fibrillation in Brugada syndrome and is associated with a high risk of syncope.

• Various morphological types of ventricular premature beats (VPBs) with fragmented QRS waves (fragmented VPBs) are often observed among patients with hypertrophic cardiomyopathy (HCM) but their significance is unknown.
Purpose

To study the significance of the number of various morphological types of fragmented VPBS on 12-lead Holter electrocardiogram (ECG) in patients with HCM.
Materials and Methods

Study Population

• Retrospective analysis of a total of 47 consecutive patients with HCM (36 male, mean 61±13 yrs) who underwent enhanced ECG-gated CT (Aquilion one or Light Speed Ultra 16) and 12 lead Holter ECG (RAC-2103) within 3 months.
• Evaluation of coronary arteries and characteristics of LV myocardium was performed.
ECG Criteria for Fragmented VPBs

• The 12-lead Holter ECGs (RAC-2103 NIHON KOHDEN, Japan) were analyzed by an experienced cardiologist who was blinded to the CT findings.
• A fragmented VPB was defined as a VPB with one or more notches in the R or S waves on a routine 12-lead Holter ECG.
• The numbers of various morphological types of VPBs and fragmented VPBs were counted.
12-lead Holter ECG
(RAC-2103 NIHON KOHDEN, Japan)
12-lead Holter ECG

Fragmented QRS wave
CT Protocol

• CT was performed in all subjects to evaluate characteristics of the coronary arteries, myocardium and cardiac function.
• If there was a contrast defect in the myocardium in the early phase, late phase acquisition was added, and if abnormal late enhancement was observed at the corresponding site, we diagnosed myocardial fibrosis.
Typical 320 Slice CT Images of myocardial fibrosis

Early phase

Late phase
## Patient Characteristics

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<table>
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<tbody>
<tr>
<td>All patients (n=47)</td>
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<tr>
<td><strong>Age (years)</strong></td>
<td>61 ± 13</td>
</tr>
<tr>
<td>Male</td>
<td>36 (77%)</td>
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<tr>
<td>Hypertension (HT)</td>
<td>16 (34%)</td>
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<td>Diabetes mellitus (DM)</td>
<td>6 (13%)</td>
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<tr>
<td>Hyperlipidemia (HL)</td>
<td>16 (34%)</td>
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<tr>
<td>Hypertrophic obstructive cardiomyopathy</td>
<td>11 (23%)</td>
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<tr>
<td>Dilated phase HCM</td>
<td>4 (9%)</td>
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<tr>
<td>Use of antiarrhythmic drugs</td>
<td>13 (28%)</td>
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Distribution of Maron HCM Types in this Study Population

- Maron: 0
- type1: 0
- type2: 16
- type3: 19
- type4: 1
- type5: 9
## Results

<table>
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<th>All patients (N=47)</th>
<th>mean ± SD or n (%)</th>
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<tr>
<td>Number of morphological types of all VPBs</td>
<td>7 ± 8</td>
<td></td>
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<tr>
<td>Number of morphological types of fragmented VPBs</td>
<td>2 ± 2</td>
<td></td>
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<tr>
<td>Presence of coronary calcification on CT</td>
<td>16 (34%)</td>
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<td>&gt;50% stenosis of any coronary artery on CT</td>
<td>4 (9%)</td>
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<td>&gt;50% stenosis of the right coronary artery (RCA) on CT</td>
<td>1 (2%)</td>
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<td>&gt;50% stenosis of the left anterior descending branch (LAD) on CT</td>
<td>3 (6%)</td>
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<tr>
<td>&gt;50% stenosis of the left circumflex artery (LCX) on CT</td>
<td>1 (2%)</td>
<td></td>
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<tr>
<td>Presence of fibrosis in LVM on CT</td>
<td>29 (62%)</td>
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</table>
There were no significant differences in the numbers of morphological types of all VPBs and those of fragmented VPBs between males and females.
Age did not significantly correlate with the number of morphological types of all VPBs or those of fragmented VPBs.
There were no significant differences in the numbers of morphological types of all VPBs and fragmented VPBs between subjects with and without DM.
There were no significant differences in the numbers of morphological types of all VPBs and those of fragmented VPBs between subjects with or without HT.
There were no significant differences in the numbers of morphological types of all VPBs and those of fragmented VPBs between subjects with or without HL.
There were no significant differences in the numbers of morphological types of all VPBs and those of fragmented VPBs between subjects with or without coronary calcification on CT.
The numbers of morphological types of both all types VPBs and fragmented VPBs were significantly lower in the subjects with any coronary stenosis than in those without any coronary stenosis.
There were no significant differences in the numbers of types of all VPBs and those of fragmented VPBs between subjects with or without RCA stenosis on CT.
There were no significant differences in the numbers of morphological types of all VPBs and those of fragmented VPBs between subjects with or without LAD stenosis on CT.
There were no significant differences in the numbers of morphological types of all VPBs and those of fragmented VPBs between subjects with or without LCX stenosis.
The numbers of morphological types of all VPBs and those of fragmented VPBs were significantly higher in the subjects with fibrosis on CT than in those without fibrosis on CT.
Correlation Coefficients between the Numbers of Morphological Types of All VPBs and Fragmented VPBs with Patient Characteristics and CT Findings

- Numbers of Morphological Types of All VPBs
- Numbers of Morphological Types of Fragmented VPBs

- Male sex
- Age
- Diabetes mellitus
- Hypertension
- Hyperlipidemia
- Coronary calcification
- Any coronary stenosis
- RCA stenosis
- LAD stenosis
- LCX stenosis
- Fibrosis on CT
Summary of the Results

• Fibrosis was observed on CT in 29 subjects.
• The numbers of morphological types of all VPBs and those of fragmented VPBs were significantly lower in the subjects with stenosis of any coronary artery than in those without any coronary stenosis.
• The numbers of morphological types of all VPBs and those of fragmented VPBs were significantly higher in the subjects with fibrosis on CT than in those without fibrosis on CT.
The numbers of morphological types of all VPBs and those of fragmented VPBs were not associated with other patient characteristics or CT findings.

Negative CCs were observed between the numbers of morphological types of all VPBs or those of fragmented VPBs and luminal stenosis ≥50% in any coronary artery and each coronary artery on CT.

Positive CCs were observed between the numbers of morphological types of all VPBs or those of fragmented VPBs and fibrosis in LV myocardium on CT.
Discussion

• Myocardial scar has been known to be an origin and a specific substrate of ventricular arrhythmia, and the border zone between scar tissue and normal LV myocardium is a known substrate for electrical instability.

• Electrocardiographically, the presence of fragmented QRS waves seemed to indicate the presence of conduction abnormalities.
• The presence of myocardial fibrosis represented by late gadolinium-enhanced cardiovascular magnetic resonance is known to be one of the predictors of sudden cardiac death.

• In this study, the numbers of morphological types of all VPBs and those of fragmented VPBs were significantly higher in the subjects with fibrosis on CT than in those without fibrosis on CT.
Limitations

- This was a retrospective, non-randomized study using a small number of HCM patients (N=47) in a single center.
- Further prospective studies are desirable in a larger population.
Conclusions

The number of morphological types of fragmented VPBs, as well as the number of morphological types of all VPBs, on a 12 lead Holter ECG may have a positive relationship with the occurrence of fibrosis in LV myocardium but a negative relationship with coronary artery stenosis on CT in HCM patients.