Ventricular Arrhythmias in the Late Hospital Phase of Acute Myocardial Infarction

Relation to Left Ventricular Function Detected by Gated Cardiac Blood Pool Scanning

By Robert A. Schulze, Jr., M.D., Jacques Rouleau, M.D., Pierre Rigo, M.D., Sally Bowers, R.N., H. William Strauss, M.D., and Bertram Pitt, M.D.

SUMMARY

Abnormalities of left ventricular function and extent of myocardial infarction were studied in relation to prevalence of late ventricular premature contractions (VPCs) in 86 patients in the convalescent stage of acute myocardial infarction (MI). Left ventricular ejection fraction (EF) and percent akinesis (%A) were calculated from gated cardiac blood pool scans; myocardial infarct size was estimated from peak CKP values; and VPCs were detected by 24 hour ambulatory ECGs 2-4 weeks following hospitalization for acute MI. Twenty-two patients had either zero (class 0) or <30/hour unifocal VPCs (class I). Fourteen patients had >30/hour unifocal (class II), multifocal (class III) or coupled VPCs (class IV), including ventricular tachycardia. Thirteen of 14 class II-IV patients had EF <40% compared with only 8 of 22 class 0-I patients. These data suggest that VPCs may not be an independent risk factor for sudden cardiac death in the convalescent phase of MI.

PREVIOUS INVESTIGATORS have suggested that patients with frequent, multifocal, or repetitive ventricular premature contractions (VPC) detected by ambulatory electrocardiographic monitoring during the convalescent phase of acute myocardial infarction may be at increased risk of cardiac death, which is especially likely to be sudden.1,2 Although decreased left ventricular function is also known to increase mortality following acute myocardial infarction3 and in patients with coronary artery disease documented at cardiac catheterization,4 a possible relationship between left ventricular function and the prevalence of ventricular arrhythmias has not been studied. In this study continuous 24 hour ambulatory electrocardiographic monitoring and gated cardiac blood pool scans were used to evaluate the extent of left ventricular dysfunction and the prevalence of ventricular arrhythmias during the late hospital phase of acute myocardial infarction.

Methods

Thirty-six patients were studied 14 to 28 days following hospitalization at the Johns Hopkins Hospital for an acute myocardial infarction. Diagnosis was based on serial ECG and creatine phosphokinase (CPK) changes. Patients were classified clinically according to the criteria proposed by Killip.4 Serum creatine phosphokinase was analyzed every four hours for 24 hours and then daily until values returned to normal (0-50 IU). In five patients peak CPK could not be determined because patients were admitted several days following onset of chest pain or were transferred from another hospital because of complications of their infarction. Informed consent was obtained from all patients.

Twenty-four hour ambulatory ECG recordings were obtained using an Avionics Research Products Electrocardioscanner Model 650 at a scanning speed of 60 times normal. Arrhythmias were printed out at a paper speed of 25 mm/sec and were analyzed without knowledge of the left ventricular function data.6 Ventricular arrhythmias were classified according to the modified criteria previously described by Lowen.7 class 0 – no ventricular ectopics, class I – occasional, isolated VPC, class II – frequent VPC occurring >30/hour in at least one hour of monitoring, class III – multifocal VPC, class IV – repetitive VPC couplets and/or salvos of ventricular tachycardia.

Left ventricular function was determined by gated cardiac blood pool scanning after injection of 200 mCi of technetium labeled albumin on the day following ambulatory
VENTRICULAR ARRHYTHMIAS IN MI

ECG recording. This technique has been described previously and left ventricular ejection fraction determined by this technique, correlated with contrast cineangiography. 

Regional myocardial wall motion was determined by superimposition of the end-diastolic and end-systolic images in both the right and left anterior oblique projections. The perimeter of the left ventricular chamber was measured in each projection excluding the area of the valve planes. The portion of the end-diastolic perimeter which overlapped the end-systolic perimeter was measured. The extent of akinesis was expressed as a percentage of the end-diastolic left ventricular perimeter in both RAO and LAO projections. The final value of %A was an average of these two percentages. For the purpose of this study dyskinetic areas were treated as akinesis. 

Calculations of ejection fraction and appreciation of segmental left ventricular wall motion abnormalities were made without prior knowledge of ambulatory ECG results. Cardiotoracic ratios were measured on six foot PA chest X-rays taken prior to discharge. 

Statistical analysis of the data was carried out using Student's unpaired t-test and Chi-square analysis.

**Results**

**Patient Presentation Characteristics**

The clinical and laboratory parameters are presented in Table 1 and figure 1 shows the prevalence and type of VPCs. Fourteen of the 36 patients had class II-IV VPCs in the late hospital phase of their acute myocardial infarction. Previous studies have shown that the classification of VPCs two weeks following MI rarely changes significantly with repeated ambulatory ECG monitoring over several months.

Development of class II-IV post-infarct VPCs did not correlate with drug therapy (including digitalis).

**Table 1**

*Clinical and Laboratory Characterization of Patients*

<table>
<thead>
<tr>
<th>Patient</th>
<th>ECG location of MI</th>
<th>Previous MI</th>
<th>Clinical class</th>
<th>VPC class</th>
<th>CT ratio</th>
<th>CKP (IU)</th>
<th>EF</th>
<th>% Akinosis</th>
<th>Antiarrhythmic therapy</th>
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<td>1</td>
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<td>No</td>
<td>III</td>
<td>0</td>
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<td>1880</td>
<td>49%</td>
<td>0</td>
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<tr>
<td>2</td>
<td>NTM - Anterior</td>
<td>No</td>
<td>I</td>
<td>0</td>
<td>.58</td>
<td>600</td>
<td>28%</td>
<td>17%</td>
<td></td>
</tr>
<tr>
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<td>2270</td>
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<td>II</td>
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<td>Q</td>
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<td>II</td>
<td>II</td>
<td>.43</td>
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<td>28%</td>
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<td>IV</td>
<td>.53</td>
<td>166</td>
<td>25%</td>
<td>32%</td>
<td>Q</td>
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</tbody>
</table>

Abbreviations: TM = transmural MI; NTM = nontransmural MI; Clinical class = Killip class on presentation; CT ratio = cardiotoracic ratio on standard PA chest X-ray; CKP = peak creatine phosphokinase; EF = left ventricular ejection fraction; Q = quinidine; PA = procaine amide.

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presence of transmural MI, electrocardiographic location of MI (anterior, posterior, inferior), history of or evidence on ECG of previous MI, or age of patient.

Twelve of 14 patients with class II–IV VPCs presented with mild to severe congestive heart failure (Killip class II or III) while 12 of 22 patients with class 0–I VPCs were not in failure (Killip class I) \( (P < 0.05) \).

Transmural MIs were present in 24 of 34 patients with VPCs prior to hospital discharge; two patients had LBBB. While 11 of 13 patients with class II–IV VPCs had transmural infarction, the increased prevalence (85% vs 62%) over patients with class 0–I VPCs with transmural infarctions was not statistically significant. Of eight patients with previous MI, six had class II–IV VPCs; however, this prevalence did not differ significantly from the prevalence of previous MI in patients with class 0–I VPCs.

Class VPCs vs Left Ventricular Ejection Fraction

Mean values for EF in class II–IV VPC patients (30.5 ± 2.3) were significantly less than in class 0–I VPC patients (49.6 ± 4.0) \( P < 0.01 \) (fig. 2). Thirteen of 14 patients with class II–IV VPCs were shown to have EFs < 40% during the late hospital phase of their acute myocardial infarction. The 22 patients with class 0–I VPCs had EFs ranging from 20% to 83% and only eight of these patients had EF < 40% (table 2).

Class VPCs vs Peak CPK

Peak CPK obtained from serial determinations has been shown to correlate well with acute myocardial infarct size, clinical class, and hemodynamic findings during presentation to the coronary care unit.\(^13\) Serial determinations of CPK to measure infarct size are an effective predictor of prognosis following infarction.\(^14\) Mean peak CPK in class II–IV VPC patients (1356 ± 187 IU) was significantly increased over mean peak CPK in class 0–I VPC patients (721 ± 155 IU) \( P < 0.05 \) (fig. 3).

Class VPCs vs % Akinesis

Mean % akinesis in class II–IV patients (28.1 ± 2.2) was significantly higher than mean % akinesis in class 0–I patients (16.9 ± 3.7) \( P < 0.05 \) (fig. 4). Thirteen of the 14 patients with complicated late VPCs had % akinesis > 20%. Eight of the 22 patients with uncomplicated late VPCs had %A > 20%.

Cardiothoracic Ratio vs Ejection Fraction

There was no significant correlation between CT ratio as measured on discharge chest X-rays and EF as measured by gated cardiac blood pool scan.

Influence of Antiarrhythmic Drug Therapy on VPC Class

Oral antiarrhythmic drug therapy was instituted in the patients in this study at the discretion of their

---

**Table 2**

<table>
<thead>
<tr>
<th>VPC class</th>
<th>( &gt; 40% )</th>
<th>( &lt; 40% )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–I</td>
<td>14</td>
<td>8</td>
</tr>
<tr>
<td>II–IV</td>
<td>1</td>
<td>13</td>
</tr>
</tbody>
</table>

---

*SCHULZE ET AL.*

1. **Figure 1**

*Incidence of the various classes of VPCs in the study population.*

2. **Figure 2**

*Relationship of EF to class VPC in the late hospital phase of acute MI. The solid lines represent mean values and the dashed lines represent one standard error of the mean. Note the significant depression of mean EF in patients with class II–IV VPCs.*

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*SCHULZE ET AL.*

1. **Table 2**

*Relationship of Late Hospital Phase VPC Class to EF*
primary physicians, generally if the patient continued to have frequent ectopic activity 72 hours following MI. Nine patients were receiving antiarrhythmic drug therapy (quinidine or procaine amide) at the time of ambulatory ECG monitoring. Since eight of these patients demonstrated class II–IV VPCs it would seem unlikely that any significant decrease in the number of class II–IV VPC patients resulted from this therapy.

**Discussion**

The relationship between left ventricular function and ventricular arrhythmias during the late hospital phase of MI has not been studied previously. Vismara et al.\(^1\) hypothesized a possible relationship of early left ventricular dysfunction and persistent myocardial ischemia with late hospital phase ventricular arrhythmias. In patients with acute myocardial infarction, they noted higher pulmonary wedge pressure and lower arterial oxygen saturation on admission and more significant ST-segment abnormalities on the discharge electrocardiogram in patients with complicated VPCs compared to those patients with rare or no VPCs during an eight hour electrocardiographic tape recording prior to discharge. No specific measurement of left ventricular function was made, however, beyond the early hospitalization period.

The results of the present study suggest a striking association between depressed left ventricular function in the late hospital phase of acute myocardial infarction as measured by EF and post MI VPCs of presumed diagnostic significance for development of sudden cardiac death. While it is possible that measurement of EF two to four weeks following acute MI may not reflect the final status of a given patient’s LV function, the data suggest that patients with class II–IV VPCs had larger MIs (significantly higher mean peak CPK), more functionally significant myocardial damage with their MIs (significantly greater mean % akinesis), and a higher but not significant increase in the prevalence of previous MI. These three factors probably explain why EF was consistently depressed in this group of patients. The single patient with complicated late VPCs and EF > 40% had an EF of 50% associated with severe mitral regurgitation. This patient eventually underwent mitral valve replacement to repair a ruptured papillary muscle.

Ventricular aneurysms, extensive left ventricular akinesis, and other ventricular wall motion abnormalities have been related to presence of ventricular arrhythmias. Bloor et al.\(^1\) have demonstrated a direct correlation between infarct size and fall in ventricular fibrillation threshold in open chest dogs. Sharma et al.\(^1\) have described a higher frequency of VPCs in patients with coronary artery disease with ventricular asynergy than in patients with coronary artery disease without ventricular asynergy. Sobel et al.\(^1\) have
demonstrated that prevalence of VPCs following MI increases with infarct size. Herman and Gorlin\(^\text{19}\) have shown by left ventricular contrast angiography that patients with > 20% akinesis or paradoxical systolic motion (as measured by LV surface area) develop either left ventricular dilatation or congestive cardiac failure. Both congestive failure and disordered LV wall motion are felt to predispose to areas of localized ischemia and re-entrant arrhythmias.\(^\text{20}\) Cure of ventricular arrhythmias with improvement of LV function has been reported following surgical resection of these akinetic and aneurysmal areas.\(^\text{21, 22}\) It should be noted that only one of our class II-IV VPC patients had % akinesis < 20%. This patient had a markedly depressed EF (20%) and a large, diffusely hypokinetic left ventricle. In addition this patient had a small posterior aneurysm measuring 12% of the left ventricular circumference.

Previous reports showing a lack of correlation between cardiothoracic ratio (CTR) measured on chest X-ray and incidence of late post MI VPCs have concluded that the occurrence of VPCs following acute MI is independent of heart size.\(^\text{5, 14, 23}\) This lack of correlation, however, is not contradictory to our findings since, as we have shown, CTR is a poor predictor of left ventricular function as measured by EF. Field et al. reported a similar lack of correlation between CTR and EF using LV contrast angiography to measure EF.\(^\text{24}\) Both our results and those of Field et al. demonstrate that the poor correlation of heart size with EF is due to the fact that many patients with normal heart size following MI can have depressed EF. The finding of gross cardiomegaly does, however, suggest depressed LV function.

In light of the association between VPCs occurring during the late phase of acute myocardial infarction and sudden cardiac death, several investigators have proposed that long term antiarrhythmic prophylaxis should be instituted to reduce the incidence of sudden cardiac death in these patients.\(^\text{23, 25, 20}\) The finding of a significant association between depressed EF and class II–IV VPCs is of interest since patients with depressed LV function have been shown to have a poor prognosis following acute myocardial infarction and may have a high risk of sudden cardiac death coincident to the presence of VPCs. Antiarrhythmic agents may abolish VPCs, but on occasion they may further depress LV function, possibly worsening prognosis. The results of the present study showing a high degree of correlation between ventricular arrhythmias and EF in the late hospital phase of acute myocardial infarction suggest that VPCs may not be an independent risk factor for death following myocardial infarction and indicate the need to determine the relative role of both LV function and VPCs in future studies on prognosis following MI. It seems reasonable to suspect that extent of myocardial damage, secondary to infarction (both recent and remote), may be the unifying hypothesis to explain the association of prevalence of VPC and LV dysfunction noted in this study.

References

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