Does the presence of hibernating myocardium in patients with impaired left ventricular contraction affect QT dispersion?

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**Background** Hibernating myocardium is associated with increased cardiovascular events. Increased QT dispersion on the surface electrocardiogram is a marker for serious ventricular arrhythmias. In this study, we determine whether hibernating myocardium is associated with increased QT dispersion in patients with coronary artery disease and impaired left ventricular contraction.

**Methods** Positron emission tomography with $^{13}$N-ammonia and $^{18}$F-fluorodeoxyglucose determined the presence of metabolic-perfusion mismatch defect. QT dispersion was measured by means of a digitizing tablet with validated software. QT intervals were measured on two separate occasions by two investigators blinded to the result of the positron emission tomography scans.

**Results** Forty-two patients with impaired left ventricular contraction were studied. They were divided into two groups: group A was made up of patients with mismatch defects ($n = 26$) and group B was made up of patients with no mismatch defects ($n = 16$). The mean (SD) QT dispersion measurements were $61.7 \pm 29.8$ ms and $70 \pm 24.6$ ms for groups A and B, respectively (not significant). When the patients were divided according to the dominant viability status of the impaired myocardial segment, a similar result was found. The patients whose impaired myocardium was dominantly hibernating ($n = 19$) had a mean QT dispersion of $66.4 \pm 31.9$ ms compared with $63.6 \pm 24.8$ ms in the patients whose impaired myocardium was mainly scarred (not significant).

**Conclusions** QT dispersion is not affected by the presence of hibernating myocardium and is therefore not clinically useful in identifying patients with this phenomenon. This is in contrast with recent reports by other groups and calls for further investigation of this dichotomy. (Am Heart J 2001;141:944-8.)

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**Hibernating myocardium** is associated with increased cardiovascular events if left unrevascularized. On the surface electrocardiogram, increased QT dispersion is a marker of the increased risk of serious ventricular arrhythmias. Schneider et al investigated whether the presence of hibernating myocardium affects QT dispersion. They concluded that hibernating myocardium is associated with reduced QT dispersion after Q-wave myocardial infarction. In their study, they acknowledged that the situation is less clear in significantly impaired left ventricles. Detection of hibernating myocardium is, however, most relevant when the left ventricle is significantly impaired. We investigated whether hibernating myocardium affects QT dispersion when left ventricular contraction is impaired.

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**Methods**

Forty-two patients with impaired left ventricular contraction caused by ischemic heart disease were studied by positron emission tomography. Surface 12-lead electrocardiograms were prospectively performed on all patients.

Myocardial perfusion and metabolism were assessed with $^{13}$N-ammonia and $^{18}$F-2-fluoro-2-deoxyglucose, respectively. The full details of the positron emission tomographic methods of image acquisition and management have been detailed elsewhere. All patients gave written informed consent before undergoing positron emission tomography. The ethics committee approved the study protocol.

**Determination of viability**

The myocardial region with the highest uptake of $^{13}$N-ammonia was taken as the reference $^{13}$N-ammonia level for that patient. The glucose uptake in that reference area was regarded as the reference uptake of $^{18}$F-2-fluoro-2-deoxyglucose. The rest of the myocardium was then compared with this reference level. Myocardial perfusion–metabolism mismatch was defined in the areas where $^{13}$N-ammonia uptake (perfusion) was reduced, $^{18}$F-2-fluoro-2-deoxyglucose uptake (metabolism) was increased, and contraction was reduced (mismatch defect) (Figure 1). This mismatch defect is suggestive of hibernating myocardium.
Effect of hibernating myocardium on QT dispersion

This was studied through two questions. The first was whether QT dispersion is affected by the mere presence of hibernating myocardium and irrespective of the presence of or the extent of accompanying scarred myocardium. A minimum of 10% of the left ventricular area showing the mismatch pattern was the threshold for assigning the patient to the hibernating myocardium group.

In the second question, the whole of the region of impaired myocardial contraction was considered, and the patients were assigned to the hibernating myocardium group only if the mismatched defect was the dominant feature of the impaired myocardial region. In the latter classification, we looked at the average $^{18}$F-2-fluoro-2-deoxyglucose uptake in the impaired myocardium. The uptake of $^{18}$F-2-fluoro-2-deoxyglucose had to exceed 50% of the reference level for the patient to be assigned to the group with dominantly hibernating myocardium. This is based on the high correlation between such a level of $^{18}$F-2-fluoro-2-deoxyglucose uptake and postrevascularization recovery of myocardial contraction.5,6

QT measurements

QT dispersion was measured on the unfiltered surface electrocardiogram by two investigators blinded to the positron emission tomography results. The measurements made by the
two observers were highly correlated ($r = 0.99$). The QT interval was defined as the segment of the electrocardiogram from the beginning of the QRS complex to the end of the T wave. The latter was defined as the point of return of the T wave to the TP baseline. In the presence of the U wave interrupting the T wave, the QT interval was measured to the nadir between the T and U waves.7

QT dispersion (QTd) and rate-corrected QT dispersion (QTcd) were measured. QT dispersion is maximum QT minus minimum QT as measured from the 12-lead electrocardiogram.8 QTcd is maximum QTc minus minimum QTc as measured from the 12-lead electrocardiogram. QTc is calculated by the Bazett formula,9 in which the native QT is divided by the square root of the corresponding R-R interval.

Maximum adjacent QT dispersion is the highest difference in the QT interval between two adjacent precordial leads. This may reflect more accurately localized abnormalities in the myocardium.10

**Table I.** Comparison between group with and group without hibernating myocardium

<table>
<thead>
<tr>
<th>Hibernation in ≥10% of LV (n = 26)</th>
<th>No hibernating myocardium (n = 16)</th>
<th>Significance, P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>62.3 ± 10.6</td>
<td>62.8 ± 7.4</td>
</tr>
<tr>
<td>Male sex</td>
<td>92%</td>
<td>75%</td>
</tr>
<tr>
<td>Ejection fraction</td>
<td>34.4% ± 12.4%</td>
<td>27.9% ± 7.9%</td>
</tr>
<tr>
<td>No. of leads</td>
<td>10.5 ± 1.5</td>
<td>9.8 ± 1.7</td>
</tr>
<tr>
<td>QTd [ms]</td>
<td>61.7 ± 29.8</td>
<td>70 ± 24.6</td>
</tr>
<tr>
<td>QTc [ms1/2]</td>
<td>62.2 ± 32.8</td>
<td>77.3 ± 28.9</td>
</tr>
<tr>
<td>Max adjacent QTd [ms]</td>
<td>41.5 ± 24.1</td>
<td>45.6 ± 20.3</td>
</tr>
</tbody>
</table>

LV, Left ventricle; NS, not significant. Statistical significance, P ≤ .05.

**Table II.** Comparison between group with dominantly hibernating myocardium and group with dominantly scarred myocardium

<table>
<thead>
<tr>
<th>Dominantly hibernating (n = 19)</th>
<th>Dominantly scarred (n = 23)</th>
<th>Significance, P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>61.6 ± 9.7</td>
<td>63.3 ± 9.3</td>
</tr>
<tr>
<td>Male sex</td>
<td>95%</td>
<td>83%</td>
</tr>
<tr>
<td>Ejection fraction</td>
<td>33.6% ± 13.2%</td>
<td>30.5% ± 9.5%</td>
</tr>
<tr>
<td>No. of leads</td>
<td>10.5 ± 1.6</td>
<td>10 ± 1.6</td>
</tr>
<tr>
<td>QTd [ms]</td>
<td>66.4 ± 31.9</td>
<td>63.6 ± 24.8</td>
</tr>
<tr>
<td>QTc [ms1/2]</td>
<td>68.5 ± 35.8</td>
<td>67.5 ± 29.1</td>
</tr>
<tr>
<td>Adjacent QTd [ms]</td>
<td>44.7 ± 26.1</td>
<td>41.7 ± 19.7</td>
</tr>
</tbody>
</table>

NS, Not significant. Statistical significance, P ≤ .05.

**Results**

**Hibernating myocardium in ≥10% of the left ventricle and QT dispersion**

There were 26 patients (24 men) with hibernating myocardium in ≥10% of the left ventricular myocardium. The 16 remaining patients (12 men) did not have hibernating myocardium. The characteristics of the patients in the two groups were comparable. There was no statistically significant difference between the two groups in any of the measured or calculated QT dispersion parameters. There was a trend for the QT dispersion parameters to be lower in the group with hibernating myocardium than in those with no hibernating myocardium. (Table I).

**QT dispersion and dominant myocardial viability state**

When the dominant feature on positron emission tomography for the impaired myocardial region was considered, the patients were divided into a group with dominantly hibernating myocardium (n = 19 patients, 17 men) and a group with dominantly scarred myocardium (n = 23 patients, 19 men). The patients in the two groups were comparable. There was no statistically significant difference between the two groups in any of the measured parameters. There was a trend toward higher QT dispersion parameters (except for maximum adjacent QTd) in the patients with dominantly hibernating myocardium (Table II).

**Discussion**

**Main study findings**

We have demonstrated that in the patients with impaired left ventricular contraction, neither the mere presence of mismatch defects nor the dominant viability status of the impaired myocardium affects QT dispersion.

**Rationale for studying the impact of hibernating myocardium on QT dispersion**

The high mortality rate of patients with severe left ventricular impairment is related, at least in part, to ventricular arrhythmia.11 Increased QT dispersion is an established marker for arrhythmia,12 particularly in patients with impaired left ventricular contraction, and in the chronic stage of myocardial infarction.13,14 On the other hand, in a large series of infarct survivors,
Zabel et al found that QT dispersion failed to predict subsequent risk. Revascularization of the impaired and ischemic myocardium could lead to improved contraction and even improved prognosis. This is particularly the case when the impaired myocardium is hibernating. It was proposed that QT dispersion could differentiate between patients with and those without hibernating myocardium in the course of chronic Q-wave myocardial infarction. However, Schneider et al rightly pointed to the need for their study to be extended to the group of patients who are at the highest risk for arrhythmia, namely those with severely impaired left ventricular contraction. These patients are also the most appropriate group to be considered for the detection of hibernating myocardium.

We therefore performed this investigation to determine whether QT dispersion is affected by the presence of hibernating myocardium.

Choice of positron emission tomography to determine myocardial viability

The best preoperative marker for the presence of hibernating myocardium is the demonstration of a perfusion-metabolism mismatch pattern on positron emission tomography, which has a high positive and negative predictive accuracy for functional improvement with revascularization. Positron emission tomography detection of hibernating myocardium relies on the biochemical behavior of the myocardium during ischemia. The ischemic myocardium is unable to metabolize its normal substrate, the free fatty acids; therefore, it switches to glucose metabolism.

In this study, we used $^{13}$N-ammonia and $^{18}$F-2-fluoro-2-deoxyglucose as the perfusion and the metabolic markers, respectively.

Potential reasons for opposing previous studies

Our cohort was a group of patients with severely impaired left ventricular contraction who underwent positron emission tomography. Schneider et al studied a group of patients with Q-wave myocardial infarction with relatively mild left ventricular impairment.

In addition, these authors excluded the positron emission tomography data from almost 40% of the myocardium (septum and lateral wall) because the wall motion data in their study was derived from the right anterior oblique view of the left ventricular angiogram. There are two problems with such an approach: (1)
The data from the whole of the electrocardiogram (including leads representing the septum and the lateral wall) were used to derive the measurements of QT dispersion; (2) the use of positron emission tomography data on less than the full left ventricle may result in misclassification of some patients (Figure 2). The conclusions derived from comparing the QT dispersion in two misclassified data sets may be invalid.

In our study, we found no difference in the QT dispersion parameters between patients with no evidence of perfusion-metabolic mismatch and those with such a defect affecting ≥10% of the myocardium. A similar result was achieved when the whole of the region with impaired contraction was considered, and the patients were classified into those with dominantly viable or scarred myocardium. Thus we concluded that the viability of the impaired myocardial wall does not affect QT dispersion.

The end of the low-amplitude T wave is difficult to determine. To avoid forcing a QT measurement, which is likely to be inaccurate, we excluded the leads in which the T-wave amplitude is low. Hence it is unlikely that our measurements were affected by T-wave amplitude.

Finally, QT dispersion has many diagnostic and prognostic utilities. However, the presence of the perfusion-metabolism mismatch pattern on positron emission tomography does not affect QT dispersion.

**Limitations of the study**

Although we recognize the relatively low number of patients studied, it is similar to that studied by Schneider et al.3

Another potentially perceived limitation is the reliance on the positron emission tomography to classify patients into groups with and those without hibernating or viable myocardium. The presence of perfusion-metabolism mismatch pattern on positron emission tomography remains the best preoperative marker for myocardial hibernation. These defects therefore can be used as surrogates for viability in studying its impact on the dispersion of myocardial repolarization. We believe this is legitimate because the aim of the study is not establishing the reliability of the mismatch defect in detecting viable myocardium but rather to study the relation between this phenomenon and QT dispersion.

**Implications and conclusions**

Our results show there is no difference between the groups with and without hibernating myocardium in terms of native QT dispersion, rate-corrected QTc dispersion, or indeed in the maximum adjacent QT dispersion. This was true irrespective of whether the mere presence of hibernating myocardium was the defining factor or whether the dominant viability status of the whole of the impaired myocardial region was considered.

**References**