The Effect of Eating on Thallium Myocardial Imaging*

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To determine if eating between initial and delayed thallium images alters the appearance of the delayed thallium scan, a prospective study was performed; 184 subjects sent for routine thallium imaging were randomized into two groups, (1) those who ate a meal high in carbohydrates between initial and delayed thallium myocardial images (n=106), and (2) those who fasted (n=78). The 201Tl images were interpreted in blinded fashion for global myocardial and pulmonary clearance of 201Tl and for the presence of transient or persistent 201Tl myocardial defects. The eating group had a significantly lower incidence of transient myocardial defects compared to the noneating group (7 percent vs 18 percent, respectively; p<0.05). The time between initial and delayed images and the incidence of exercise-induced ischemic ST-segment depression or pathologic Q waves on the electrocardiogram were not significantly different between the two groups. These data suggest that eating a high-carbohydrate meal between initial and delayed 201Tl images causes increased 201Tl myocardial clearance rates and may alter 201Tl myocardial redistribution over time.

Although initial distribution of thallium 201 in the myocardium is proportional to regional myocardial blood flow,1 underperfused but viable ("ischemic") zones demonstrate redistribution over time.2 Recent studies have demonstrated that one mechanism for this redistribution is the slower 201Tl clearance from ischemic compared to normally perfused myocardium.3 4 Since 201Tl is a potassium analogue, its myocardial kinetics could be affected by glucose and insulin. Recent studies in our laboratory using dogs5 with transient ischemia demonstrated that an intravenous infusion of a glucose-insulin-potassium combination significantly increased the net clearance rate of myocardial 201Tl from both normally perfused and transiently ischemic myocardium. The result of this increase in clearance from both zones was a decrease in the extent of 201Tl redistribution into regions of transient ischemia.7

Although glucose-insulin-potassium infusion is not commonly used clinically, a comparable effect might be achieved if a patient ate a meal high in carbohydrates between initial and delayed images; however, it is not known whether such a meal could affect the occurrence of transient vs persistent myocardial lesions. Accordingly, 184 patients undergoing exercise 201Tl myocardial studies for the evaluation of chest pain syndromes were studied with a prospective protocol. Patients were randomized into two groups: (1) those who ate between initial and delayed 201Tl images, and (2) those who fasted over this period. The scans were evaluated in a blinded manner for 201Tl myocardial clearance and the incidence of transient and persistent defects in the two groups.

Materials and Methods

Population of Patients

Over a four-month interval, all patients undergoing routine stress thallium imaging for chest pain syndromes were considered for participation in the trial. Of the 200 candidates, a total of 184 agreed to participate and were prospectively randomized into two groups: (1) those who ate a high-carbohydrate meal (containing a bread, a sugar-containing soft drink or milk, and a dessert) between initial and delayed thallium images (n=92), and (2) those who fasted (n=92) (water, black coffee or tea, or noncaloric soft drinks were permitted). Patients with the diagnosis of diabetes mellitus were excluded from the study. To simulate current clinical practice, the time at which patients ate was not controlled. All patients had fasted overnight before exercise testing and initial imaging. Unfortunately, 14 patients assigned to the fasting group had some calorie-containing snack between the initial and delayed scan and were therefore included in the eating group. Thus, the fasting group consisted of 78 patients and the eating group 106 patients.

Protocol for Exercise Test

Treadmill exercise tests were performed using the standard Bruce protocol with continuous electrocardiographic and cuff blood pressure monitoring. Sixty seconds prior to the anticipated termination of exercise, 1.5 to 2.0 mCi (46 to 74 mBq) of 201Tl (New England Nuclear Corp.) was injected intravenously.

Exercise was terminated for chest pain, ventricular tachycardia, a fall of 10 mm Hg or more in systolic pressure, significant ST-segment depression, or generalized fatigue or dyspnea.

The electrocardiographic criteria for ischemia was 1 mm or more of

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horizontal or downward sloping ST-segment depression 0.08 second after the J point in three consecutive beats in leads where no significant baseline ST-segment abnormalities were present.

**Acquisition and Randomization of Images**

Myocardial imaging with \(^{201}\)TI commenced within five minutes of the end of the exercise. Anterior and 45° and 70° left anterior oblique images were obtained using a 25-cm diameter field of view Anger-type scintillation camera with a general-purpose collimator (Ohio-Nuclear series 100), interfaced with a dedicated computer system (Ohio-Nuclear 450 computer; Technicare Corp.). Each image was acquired for eight minutes into a 64 × 64 matrix.

**Analysis of Images**

The time between injection and the delayed images was measured for each subject. The initial and delayed \(^{201}\)TI images were qualitatively interpreted using the computer display by two experienced observers without knowledge of the patient’s eating or fasting status. Focal abnormalities on the initial set of images that resolved on the delayed set of images (transient defects) were interpreted as representing exercise-induced myocardial ischemia, and abnormalities which persisted were interpreted as representing myocardial scar.

The clearance of \(^{201}\)TI from the anterior and inferior myocardium, as well as the left lung, was quantitatively determined on the anterior projection of initial and delayed images, as it was the most reproducible view. Regions of interest were drawn over the left lung and anterior and inferior myocardial walls, and \(^{201}\)TI activity in these regions was expressed as counts per picture element. No background was subtracted. The percentage of clearance of \(^{201}\)TI from these regions was calculated as follows:

\[
\text{initial counts/pixel} - \text{delayed counts/pixel} \times 100\%
\]

**Statistical Analysis**

Results were expressed as a mean ± 1 SD. Differences between groups of patients were analyzed using a one-way analysis of variance. Proportions of patient in various subgroups were compared using a \(x^2\) analysis.

**RESULTS**

To determine the anticipated incidence of scar, the two groups were compared for their clinical status (Table 1). There were no significant differences in age, sex, incidence of Q waves on the resting electrocardiogram, rate-pressure product at peak exercise, exercise-induced ST-segment depression, or the use of \(\beta\)-adrenergic blockers or nitrates.

The thallium scans were abnormal in 56 percent (44/78) of fasting and 58 percent of the eating patients (not significant) (Table 2). The incidence of patients with transient abnormalities on their thallium scans was 18 percent (14/78) in the fasting group but only 7 percent in the eating group (p<0.05). There was a similar discrepancy, in the opposite direction, for persistent abnormalities, 26 percent in the eating group but only 17 percent (13/78) in the fasting group (p<0.05). The occurrence of combined transient and fixed abnormalities of perfusion was similar in both groups (23 percent [18/78] for the fasting group, compared to 22 percent for the eating group [not significant]).

The time from the initial to delayed \(^{201}\)TI images was not significantly different between eating and fasting groups (3.77 ± 0.72 and 3.75 ± 0.61 hours, respectively). The mean (±SD) values for counts per pixel on the initial images were 281 ± 93 and 268 ± 90, respectively, for the anterior and inferior myocardial regions (not significant). The \(^{201}\)TI clearance from the anterior and inferior myocardial walls in the eating group was 42.9 ± 9.8 percent and 38.7 ± 10.1 percent; these values were significantly different from those in

**Table 2—Distribution of Transient and Persistent Defects in Two Groups of Patients***

<table>
<thead>
<tr>
<th>Defects</th>
<th>Eating Group (n = 106)</th>
<th>Fasting Group (n = 78)</th>
<th>p Value†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolated transient TI defects</td>
<td>8 (8)</td>
<td>14 (18)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Isolated persistent TI defects</td>
<td>28 (26)</td>
<td>13 (17)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Both transient and persistent TI defects</td>
<td>23 (22)</td>
<td>18 (23)</td>
<td>NS</td>
</tr>
<tr>
<td>No TI defects</td>
<td>47 (44)</td>
<td>33 (42)</td>
<td>NS</td>
</tr>
</tbody>
</table>

*Table data are numbers of subjects; numbers within parentheses are percentages.
†NS, Not significant.

**Table 3—Clearance Rates for Two Groups of Patients**

<table>
<thead>
<tr>
<th>Data</th>
<th>Eating Group (n = 106)</th>
<th>Fasting Group (n = 78)</th>
<th>p Value†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time from initial to delayed images, hr</td>
<td>3.77 ± 0.72</td>
<td>3.75 ± 0.61</td>
<td>NS</td>
</tr>
<tr>
<td>(^{201})TI clearance, percent†</td>
<td>42.9 ± 9.8</td>
<td>30.4 ± 10.5</td>
<td>&lt;0.02</td>
</tr>
<tr>
<td>Anterior myocardial wall</td>
<td>38.7 ± 10.1</td>
<td>34.6 ± 11.8</td>
<td>&lt;0.02</td>
</tr>
<tr>
<td>Inferior myocardial wall</td>
<td>44.6 ± 11.0</td>
<td>42.3 ± 8.2</td>
<td>NS</td>
</tr>
</tbody>
</table>

*Table data are means ± SD.
†NS, Not significant.
‡Percentage of clearance between initial and delayed images.

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**Effect of Eating on Thallium Myocardial Imaging (Wilson et al)**
Table 4—Clinical Features of Patients with Single Transients or Persistent Defects*

<table>
<thead>
<tr>
<th>Data</th>
<th>Eating Group (n = 36)</th>
<th>Fasting Group (n = 27)</th>
<th>p</th>
<th>Value†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exercise-induced ST-segment depression</td>
<td>11 (31)</td>
<td>9 (33)</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Q waves</td>
<td>24 (67)</td>
<td>12 (44)</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Rate-pressure product‡</td>
<td>22,908 ± 5,831</td>
<td>24,571 ± 5,403</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>β-Adrenergic blockade therapy§</td>
<td>18 (50)</td>
<td>14 (52)</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Nitrate therapy§</td>
<td>19 (53)</td>
<td>10 (37)</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Time from initial to delayed images, hr</td>
<td>3.7 ± 0.7</td>
<td>3.8 ± 0.5</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Isolated transient defects</td>
<td>8 (22)</td>
<td>14 (52)</td>
<td>&lt;0.05</td>
<td></td>
</tr>
<tr>
<td>Isolated persistent defects</td>
<td>28 (78)</td>
<td>13 (48)</td>
<td>&lt;0.05</td>
<td></td>
</tr>
</tbody>
</table>

*Table data are numbers of subjects; numbers within parentheses are percentages.
†NS: Not significant.
‡Heart rate in beats per minute times blood pressure in millimeters of mercury.
§On therapy during imaging period.

the fasting group (39.4 ± 10.5 percent and 34.6 ± 11.8 percent, respectively, p<0.02, Table 3). There was no significant difference in pulmonary washout rate between the two groups.

To determine if the eating status of the patients played a significant role in patients with a single $^{201}$TI defect, a separate analysis was performed in the patients with an isolated transient (n = 22) or an isolated persistent (n = 41) defect (Table 4). In these 63 patients the incidence of Q waves and exercise-induced ST-segment depression and the use of propranolol or nitrates were not significantly different. Similarly, the time from initial to delayed image and the rate-pressure product at peak exercise were also similar in the eating and fasting groups; however, the incidence of isolated transient defects (22 percent [8/36] for the eating group vs 52 percent [14/27] for the fasting group; p<0.05) and isolated persistent defects (78 percent [28/36] for the eating group vs 48 percent [13/27] for the fasting group; p<0.05) were both significantly different between the eating and fasting groups.

**Discussion**

This randomized prospective trial suggests that eating between the initial and delayed thallium scans is associated with both a higher incidence of persistent thallium myocardial defects and a lower incidence of transient lesions. Although the patients in this series did not undergo cardiac catheterization, there was no difference in the incidence of electrocardiographic abnormalities at rest or at exercise, use of medication that could influence the outcome of treadmill testing, or the age or sex of the patients. Therefore, on *a priori* grounds, an equal incidence of persistent and transient lesions would be expected in the two groups; however, if eating a high-carbohydrate meal had the same influence in man as demonstrated in the dog, where clearance of thallium from both transiently ischemic and normal myocardium were both accelerated, then both a higher incidence of persistent lesions and a lower incidence of transient lesions would be expected. Both were observed. In addition, quantitation of the percentage of thallium lost from the normal zones of myocardium revealed accelerated clearance in the eating group from both the anterior and inferior myocardial regions. These regions were analyzed separately to avoid a possible effect of pulmonary overlap on the anterior wall.

Alternatively, an increase in hepatic $^{201}$TI activity between initial and delayed images may be causing scattered radiation into the inferior wall region, resulting in lower perceived inferior myocardial $^{201}$TI clearance rates. Background subtractions algorithms or single photon emission tomography (or both) may have lessened the influence of pulmonary and hepatic contributions to "myocardial" counts.

Although the mechanism by which eating alters thallium clearance is not known, it is postulated that eating a high-carbohydrate meal stimulates endogenous insulin secretion, which may alter $^{201}$TI myocardial kinetics. In addition, since ischemic myocardium tends to use glucose rather than free fatty acids as a metabolic substrate, the changes in $^{201}$TI redistribution and clearance induced by glucose-insulin-potassium infusion and possibly eating may be the result of the increased dependence of ischemic as opposed to normal myocardium on glucose metabolism.

Since this study suggests that eating can influence the rate of thallium loss from the myocardium, it may be prudent to have patients limit their intake of carbohydrates between initial and delayed thallium scans. This may be particularly important when $^{201}$TI myocardial clearance rates will be used as a criterion for myocardial ischemia. Furthermore, this study suggests that areas of jeopardized (ischemic) but viable myocardium could be misinterpreted as scar if the patient is allowed to eat between initial and delayed $^{201}$TI images. Thus, the amount of ischemic jeopardized myocardium may be underestimated, and, as a result, inappropriate clinical decisions may be made concerning the need for coronary arterial bypass surgery or angioplasty or more aggressive medical therapy. To eliminate the influence of eating on $^{201}$TI myocardial imaging, it is recommended that patients fast between initial and delayed images.

**Acknowledgment:** We are grateful for the excellent secretarial assistance of Ms. Eleanor Plati and Ms. Barbara Lewis.
REFERENCES

VI International Symposium on Intensive Care and Emergency Medicine

The Department of Intensive Care and Emergency Medicine of Erasme University Hospital (Free University of Brussels), in association with the Belgian Society of Intensive Care, will sponsor this program at the Brussels (Belgium) Convention Center, April 15-18. For information, contact Dr. J. L. Vincent, Department of Intensive Care, Erasme University Hospital, Route de Lennik 808, 1070 Brussels, Belgium.

Symposium on Chronic Obstructive Pulmonary Disease

This symposium will be held at the Sheraton Inn, Madison, Wisconsin, March 6-7. Sponsors are Continuing Medical Education, School of Medicine; Pulmonary Section, Department of Medicine, School of Medicine; and Departments of Nursing and Respiratory Therapy, Clinical Science Center, University of Wisconsin-Madison. For information, contact Ms. Sarah Z. Aslakson, Continuing Medical Education, 465B WARP Building, 610 Walnut Street, Madison 53705 (608:263-2856).