Unstable Angina Pectoris

— Changes in the ST-T Segment during Daily Activities such as Bathing, Eating, Defecating and Urinating —

TERUHISA TANABE, M.D., AND YUICHIRO GOTO, M.D.

The significance of positive ST-T changes during bathing, eating, defecating and urinating was studied in 103 patients with ischemic heart disease using Holter and 12-lead ECG. The incidence of positive ST-T changes was very high in patients with unstable angina (US) and in those with old myocardial infarction (OMI) associated with unstable angina. However, it was relatively low in angina-free OMI and extremely low in stable angina.

Positive ST-T changes during defecation and urination were mostly (70% and 73%, respectively) seen from night to early morning.

With regard to showering or eating, the incidence of positive ST-T changes was low during spraying hot water on the body without motion or remaining motionless after eating. It was not until light exertion was added that the incidence increased. However, pressure-rate product after such behavior did not always increase as compared with that before them.

Consequently, it is suggested that the mechanism of anginal attack during urination may be similar to that of variant angina. With regard to showering or eating, it is considered that the spraying of hot water or food intake may bring about a change in the cardiac autonomic nerve tone, and that the addition of light exertion can easily induce myocardial ischemia which is not due to an increase in the oxygen demand of the myocardium.

ISCHEMIC chest pain in patients with unstable angina pectoris often occurs not only during exertion and at rest but also concomitant with daily activities such as bathing, eating, defecation and urination.

However, there have been very few reports that have dealt with the significance of angina pectoris associated with the daily activities on the basis of ST-T changes on a Holter electrocardiogram\(^1\)–\(^4\)

The present study was performed to investigate the incidence of positive ST-T changes of ECG during bathing, eating, defecation and urination in patients with unstable angina pectoris and to clarify a part of the mechanism of ST-T changes in such cases.

SUBJECTS AND METHODS

The subjects included 103 patients with ischemic heart disease admitted to or seen at the Out-patients Clinic of Tokai University Hospital from April 1 to November 30, 1981 and 18 normal cases as a control.

These cases were divided into 5 groups as shown in Table I: Group 1, unstable angina pectoris with no history of previous myocardial infarction (UA); Group 2, stable angina pectoris with no history of previous myocardial infarction

Key Words:
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ST-T changes
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TABLE 1 NUMBER OF SUBJECTS AND AGES

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
<th>Age (years) (mean)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angina pectoris</td>
<td>UA</td>
<td>25</td>
<td>5</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>37 – 71 (54.4)</td>
</tr>
<tr>
<td></td>
<td>SA</td>
<td>13</td>
<td>3</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>51 – 69 (56.6)</td>
</tr>
<tr>
<td>Old myocardial infarction</td>
<td>OMI-U</td>
<td>12</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>42 – 80 (60.4)</td>
</tr>
<tr>
<td></td>
<td>OMI-S</td>
<td>14</td>
<td>8</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>40 – 84 (59.4)</td>
</tr>
<tr>
<td>No heart disease</td>
<td>16</td>
<td>2</td>
<td>18</td>
<td>38 – 69 (52.1)</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>21</td>
<td>121</td>
<td></td>
</tr>
</tbody>
</table>

UA = unstable angina; SA = stable angina, OMI = old myocardial infarction, OMI-U = OMI + unstable angina; OMI-S = OMI + stable angina

HOT BATH

Fig.1. Holter monitoring recording on bathing and coronary arteriogram in a 38-year-old male patient with unstable angina pectoris.

(SA); Group 3, unstable angina pectoris with a history of previous myocardial infarction (OMI-U); Group 4, free from angina pectoris or in a stable state at present with a history of previous myocardial infarction (OMI-S); Group 5, normal cases.

The number of cases in each group and their ages are also shown in Table 1. The diagnostic criteria for unstable angina pectoris proposed by the American Heart Association in 1975 was used.

Electrocardiograms (ECGs) were recorded using a Holter System Model 425 Electrocardiograph (Del Mar Avionics Corp.) and analyzed by Model 660 Dynamic Electroscanner (Del Mar Avionics Corp.).

In recording the ECG, 2 bipolar monitoring leads were employed. For recording a QRS complex resembling V₅ on a 12-lead ECG (Channel One), the exploring electrode was

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placed at the V₄ position and the negative electrode to the left of the manubrium sterni. For recording a QRS complex resembling V₁ or V₂ (Channel Two), the exploring electrode was placed at the fourth intercostal space immediately to the right of the sternum and the negative electrode at the same site as that in Channel One.

The patient was instructed to write the time of bathing, eating, defecation and urination accurately and to keep a written diary of the presence or absence, severity and duration of the symptoms.

The patients with UA and OMI-U were all given antianginal agents such as nitrates, Ca²⁺ antagonists and β-blockade. These patients having frequent anginal attacks were not allowed to take a bath during such frequent attack periods.

A “shower examination” was performed in patients with UA and OMI-U to find out whether ST-T changes were caused by hot water or by exertion during the shower. ECG was recorded by the 12-lead technique in this examination. To begin with, hot water of 37°C and 42°C was sprayed on the lower limbs, hips and back in succession. If significant ST-T changes were absent on the ECG, the patients were instructed to wash their bodies vigorously with a cloth soaked in hot water (“hot water washing”) for several minutes.

The patients, in whom significant ST-T changes appeared by “hot water washing”, were instructed to scrub their bodies again with a dry cloth (“dry cloth scrubbing”) for the same period as “hot water washing”, approximately one hour after the disappearance of the ST-T changes.

Whether significant ST-T changes were caused by increased movement of the gastrointestinal tract due to an ingestion of food or by “light exertion” after a meal was studied using the 12-lead ECG method (“eating examination”). For this purpose, the incidence of positive ST-T changes was compared among the 3 conditions of rest after a meal, light exertion (30m-walk) without a meal and light exertion (30m-walk) after a meal in UA and OMI-U.

ST-T changes on ECG were considered positive when they possessed all of the following 3 items:

1) ST segment displacement of horizontal or sagging type was 0.1 mV or more in depth by the Holter ECG method and 0.05 mV or more by the 12-lead ECG method and/or T
waves turned from positive to negative.

2) The above-mentioned ST-T changes lasted at least one minute.

3) The above-mentioned ST-T changes were consistent with the time of the daily activities written in the diary.

RESULTS

Figure 1 shows Holter ECGs just after bathing in a 38-year-old male patient with UA and his left coronary arteriogram performed on another occasion. Anginal pain almost ceased subjectively after an administration of Ca antagonists, but a transient elevation or depression of the ST segments without symptoms were often seen on Holter monitoring recordings. As shown in this figure, asymptomatic slight ST segment depression is observed on bathing. The coronary angiogram exhibits severe stenosis at the proximal part of the left anterior descending artery.

Figure 2 shows Holter ECGs and a coronary arteriogram in a 70-year-old male with anginal pain after meals. This ECG was recorded when anginal pain occurred during walking after breakfast on the day after admission. Marked depression of the ST segment is seen. The coronary arteriogram shows a 90% stenosis at the proximal part of the left anterior descending artery.

Figure 3 reveals Holter ECG on urination in a 56-year-old man in whom stable effort angina pectoris changed to unstable angina pectoris. The ST segments were described as a downward curve and seen sagging gradually. Characteristically, the pulse rate decreased as the ST segments were depressed.

Figure 4 shows a comparison of the incidences of positive changes in the ST-T segments on the Holter ECGs on bathing, eating, defecation and urination in the patients with UA and SA. The incidences of positive changes in the ST-T segments were 62% in UA and 7% in SA (p<0.001) on bathing, 36% in UA and 8% in SA (p<0.001) on eating, 33% in UA and 0% in SA (p<0.005) on defecation, and 26% in UA and 0% in SA (p<0.001) on urination. That is, the incidence of positive changes in the ST-T segment was very high in UA as compared with that in SA.

However, there were very few patients in whom anginal symptoms occurred simultaneously with these positive changes in the ST-T segment, that is, 3 patients each on bathing and eating and one patient each on defecation and urination.

Figure 5 also shows a comparison between OMI-U and OMI-S. The incidences of positive ST-T changes were 45% in OMI-U and 14% in OMI-S (p<0.05) on bathing, 42% in OMI-U and

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12% in OMI-S (p < 0.05) on eating, 22% in OMI-U and 19% in OMI-S not significant on defecation, and 27% in OMI-U and 19% in OMI-S (not significant) on urination.

In other words, positive changes of the ST-T segments appeared in a certain incidence not only in OMI-U but also even in OMI-S. However, similar to angina pectoris, patients having simultaneous anginal symptoms with positive ST-T segment changes were extremely few, being only 2 cases during bathing and one case during eating.

In 18 normal controls, there were no positive electrocardiographic ST-T changes during daily activities such as bathing, eating, defecation and urination.

Next, the approximate time, at which positives ST-T changes occur during eating, defecation and urination, was studied using Holter monitoring recordings.

In regard to eating, 21 positive ST-T changes were observed in 19 patients. Fifteen of the 21 changes (71%) were seen at breakfast, 2 (10%) at lunch and 4 (19%) at supper (Fig. 6A). That is, the positive ST-T changes appeared most frequently at breakfast.

In regard to defecation, 7 out of 10 positive ST-T changes (70%) were seen between 0:00 and 9:00 AM, that is, from midnight to early morning (Fig. 6B). Regarding urination, 15 positive ST-T changes were observed in 13 patients and 13 of the 15 changes (87%) were seen from night to early morning (Fig. 6B).

Figure 7 shows the number of patients with positive ST-T changes with spraying hot water, “hot water washing” and “dry cloth scrubbing” in UA and OMI-U.

Out of 25 patients, the positive ST-T changes were seen in 4 (16%) with hot water of 37°C and in 6 (24%) with that of 42°C during the spraying on their backs. On the other hand, the changes were observed in 16 out of 22 patients (73%) during “hot water washing” and in 4 out of 16 patients (25%) during “dry cloth scrubbing”. That is, the positive ST-T changes appeared most frequently during “hot water washing”.

Symptoms of angina appeared in 5 out of 22 patients (23%) during “hot water washing” and one out of 16 patients (6%) during “dry cloth scrubbing”.

Increases in the myocardial oxygen demand parallels those of the pressure-rate product (PRP). The difference of the degree of increase in the myocardial oxygen demand between the positive
Fig. 6. Comparison of the incidence of positive ST-T changes among breakfast, lunch and dinner (A) and the time of day ST-T change appeared on defecation and urination (B).

Fig. 7. Comparison of the incidence of positive ST-T changes among the spraying of hot water, "hot water washing" and "dry cloth scrubbing" in UA and OMI-U. UA = unstable angina; OMI-U = old myocardial infarction with unstable angina

ST-T change group (n = 16) and the negative ST-T change group (n = 6) was studied by calculating the PRP. As a result, there was no significant difference in the PRP between the 2 groups after showering.

Figure 8 shows the number of patients with positive ST-T changes on eating, walking and walking after eating. Positive ST-T changes were observed in 4 out of 31 patients (31%), one out of 9 patients (11%) and 9 out of 10 patients (70%), respectively. That is, the ST-T changes were liable to occur most frequently when eating was combined with light exertion.

After eating the PRP decreased slightly in 6
DISCUSSION

In the present Holter monitoring study, the incidence of positive ST-T segment changes during daily activities was very high in UA and OMI-U and relatively high in OMI-S. However, patients who complained of angina consistent with the episodes of the positive ST-T changes were few.

Recently, there have been reports that transient asymptomatic ST-T changes were seen during Holter monitoring observations in patients with ischemic heart disease. Schang et al. have reported that 411 transient episodes of ischemic type ST depression were noted during usual daily activities and that only 101 (25%) of these episodes were associated with angina. Biagni et al. have reported that in unstable anginal patients, 88% of transient ECG alterations observed during Holter monitoring were either characterized by complete absence of symptoms or by only ill-defined sensations. As the explanation of this finding, they assumed that acute transient myocardial ischemia is associated with a continuous spectrum of clinical symptomatology: from complete absence of symptoms to dyspnea, weakness and atypical pain to typical angina episodes and that these manifestations may vary from one episode to another in the same patients.

This assumption can be conveniently applied to our patients because we can maintain that antianginal drugs used in our patients were able to suppress anginal attacks clinically but were not sufficient to improve the asymptomatic ST-T segment alterations which appeared subclinically in the same patients.

Furthermore, Biagni et al. have performed coronary arteriography during asymptomatic ST-T changes and in 6 out of 8 patients they demonstrated that these ECG changes were associated with complete or incomplete coronary spasm, which is a finding suggesting that the ECG alterations observed on ambulatory monitoring were caused by a sudden reduction of the coronary blood flow due to spasm.

In our “shower examination”, anginal symptoms appeared in 5 out of 16 patients during “hot water washing”. In 3 of these 5, 24-hour Holter monitoring ECGs were recorded on the same day. As a result, transient positive ST-T changes were frequently shown not only during the shower examination time, when the patients complained of angina, but also at other times, such as eating, defecating or urinating, having no anginal symptoms.

Therefore, it is suggested that asymptomatic positive ST-T alterations on a 24-hour ECG in our patients were also caused by myocardial ischemia probably due to spasm.

Positive ST-T changes on defecation and urination were mostly (70% and 73%, respectively) seen from night to early morning. This is consistent with the onset time of variant angina in which the coronary arterial spasm is related to ST-T alterations.

In angina of micturition, it has been reported that the heart rate increased slightly and the blood pressure rose 10 to 20 mmHg with the onset of chest pain. On the other hand, there has been a report that the increase in heart rate and the rise in blood pressure preceded the ST segment depression.

In some of our patients with positive ST-T changes on urination, the decreases in heart rate were shown with an augmentation of ST segment depression. In addition, despite the fact that the frequency of urination was high during the daytime and that the myocardial oxygen demand is high during the day, positive ST-T changes were often observed from night to early morning when the myocardial oxygen demand is low.
Accordingly, it is not likely that an increase in the myocardial oxygen demand is primarily related to the mechanism operating in angina of micturition. The presence of other mechanisms, for instance, myocardial ischemia due to coronary arterial spasm, may be suggested.

As previously reported by us, patients having a high PRP after bathing did not necessarily show more ST-T changes as compared with the patients having a low PRP. In the present study, the PRP after showering in the positive ST-T change group did not significantly increase as compared with that in the negative ST-T change group.

As for the “eating examination”, in a large number of patients (75%) with positive ST-T changes the PRP after eating did not increase as compared with that before eating.

From these findings it may not be considered that an increase in the myocardial oxygen demand is primarily related to the mechanism of positive ST-T change during showering or eating.

Recently, there have been reports that coronary arterial spasm occurred during exertion, too. Yasue et al. have observed that 4 patients with exertional angina induced by arm exercise were shown to have coronary arterial spasm during the attack. Boden et al. have performed coronary angiography during an isometric arm exercise test in one patient with a history of typical effort angina, which had developed into angina at rest recently, and they demonstrated severe localized and reversible coronary spasm at the proximal part of the left anterior descending coronary artery during an isometric arm exercise. Therefore, it is considered that coronary arterial spasm may be produced by relatively light exertion.

In the present study, the incidence of positive ST-T changes was low when the patient merely sprayed hot water on his body without exercise or when he remained motionless after a meal. However, when even light exertion was added in each examination, the incidence of positive ST-T changes increased.

This suggests that at first the spraying of hot water or the ingestion of food may bring about a change in the cardiac autonomic nerve tone in patients with unstable angina pectoris, and then the addition of light exertion may easily induce coronary arterial spasm and subsequently myocardial ischemia.

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