Combination of Ambulatory Electrocardiographic Monitoring and Psychological Testing in Coronary Artery Disease Patients

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Ambulatory electrocardiographic monitoring and psychological testing were performed in 100 patients with chronic stable myocardial infarction. These patients were divided into four groups according to their chest pain and transient ST-segment depression by Holter monitoring during the follow-up period: group A, 40 patients without complications; group B, 20 patients with silent myocardial ischemia; group C, 14 patients with episodes of chest pain alone; and group D, 26 patients with postinfarction angina. Whereas group B had silent myocardial ischemia and extroversion, groups C and D were characterized by introversion and neuroticism. The frequency of multi-vessel disease was 41% for group A, 53% for group B, 8% for group C and 70% for group D. The patients of group B not only received treatment for coronary artery disease but also behavioral counseling and those of group C received psychotherapy. The results support the view that a combination of Holter monitoring and psychological testing is clinically useful for the development of therapeutic strategies for coronary artery disease.

Key words: Holter monitoring, Myocardial infarction, Angina pectoris, Silent myocardial ischemia, Behavioral counseling, Psychotherapy

Myocardial infarction (MI) can be complicated by various conditions, such as angina pectoris, arrhythmia and heart failure; coronary artery disease patients with such complications have a poor prognosis (1–3). Furthermore, these complications can also be regarded as the cause of sudden cardiac death (4, 5). On the other hand, there have been reports that the onset of transient myocardial ischemia may not be signaled by subjective symptoms (6–8) and that MI patients with episodes of transient myocardial ischemia carry a poorer prognosis than those without transient myocardial ischemia, irregardless of whether the onset of transient myocardial ischemia is accompanied by subjective symptoms (9, 10). In light of these facts it can be said that early detection of silent myocardial ischemia is important in the treatment of coronary artery disease. On the other hand, there are cases where ambulatory electrocardiographic monitoring and exercise thallium imaging are negative in spite of the presence of complaints such as chest pain, chest discomfort and shortness of breath. This fact indicates the differentiation of angina pectoris from neuroticism, since, as is often the case, psychoneurotic factors are found in those patients.

The present study was undertaken in an attempt to determine the clinical usefulness of ambulatory electrocardiographic monitoring combined with personal and psychological tests as a means to develop therapeutic strategies for coronary artery disease. The patients with a past MI who were examined by these tests were divided into four groups according to whether they had episodes of chest pain and myocardial ischemia. The groups were compared...
with respect to personal and psychological conditions and the clinical characteristics of the disease. Furthermore, the patients with angina pectoris without a history of MI were divided into two groups: a group of patients with predominantly symptomatic ischemic episodes and a group of patients with predominantly asymptomatic ischemic episodes. These two groups were also compared with respect to the same parameters as above.

MATERIALS AND METHODS

1. Subjects

This study was carried out on 100 non-recent MI patients being treated at the outpatient clinic of Nippon Medical School Hospital (87 males and 13 females of average age 60 ± 10 years). The mean follow-up period was 52 ± 43 months (with a range of 6 to 110 months). The 100 MI patients chosen were those with such complications as angina pectoris, arrhythmia and congestive heart failure which had been treated with antianginal drugs, antiarrhythmic drugs and diuretics to achieve a chronic stable condition.

The subjects were divided into 4 groups according to whether they had chest pain during the follow-up period and the degree of transient ST-segment depression during ambulatory electrocardiographic monitoring: group A, 40 patients without chest pain or transient ST-segment depression; group B, 20 patients without chest pain associated with transient ST-segment depression; group C, 14 patients with chest pain unassociated with transient ST-segment depression; and group D, 26 patients with both chest pain and transient ST-segment depression. The mean follow-up periods for these groups were 48 ± 42, 61 ± 48, 48 ± 43 and 52 ± 42 months, respectively. The possibility of esophageal disorders, gall bladder disease, sleep apnea and other diseases that can give rise to chest pain were ruled out in the patients of group C. Moreover, no redistribution 3 h after thallium-201 injection was present in group C on postexercise images. For groups A, B and D, the frequencies of redistribution in exercise thallium imaging were 20%, 100% and 91%, respectively. The 44 patients with chronic stable exertional angina (36 males and 8 females of average age 60 ± 8 years) were divided into 2 groups (E and F) according to the criteria of Glazier et al (11): group E, 31 patients in whom at least 50% of transient ST depression episodes induced during 48-h ambulatory electrocardiographic monitoring were symptomatic, and group F, 13 patients in whom at least 90% or more of such episodes were asymptomatic. Exercise thallium imaging was done on 25 and 10 patients of groups E and F, and the frequencies of redistribution were 92% and 100%, respectively.

2. Ambulatory electrocardiographic monitoring

Ambulatory electrocardiographic monitoring was performed in two 24-h sessions under stable conditions of the clinical course, using Del-Mar Avionics tape recorders (Model 445), and ECG tracings were obtained on 2 channels; on one maximum ST-segment depression was observed except in the leads exhibiting QS patterns and Q waves. An episode of ischemia was defined as transient ≥1 mm horizontal or down-sloping ST-segment depression of at least a 60-s duration. Episodes were considered symptomatic if ST-segment depression was accompanied by subjective symptoms, and asymptomatic if not accompanied by subjective symptoms.

3. Personal and psychological testing

In the present study, Maudsley Personality Inventory (MPI), as performed according to Eysenck (12) and Jensen (13) is a test designed to check patients for both neuroticism and extroversion or introversion. This test is performed using two scales, N (neuroticism) and E (extroversion). In cases where high scores are obtained, the N scale is referred to for neuroticism and the E scale for extroversion. It has been ascertained that the Japanese version of MPI (14) which was used in the present study, has as high a coefficient of reliability as the original MPI (14).

In addition to MPI, the Cornell Medical Index (CMI) (15) was also employed as a simple screening test for neurosis. MPI, CMI and ambulatory electrocardiographic monitoring were concurrently performed.

MPI and CMI were also performed on 28 age-adjusted normal controls (19 males and 9 females average age 57 ± 9 years) for the purpose of comparison.

4. Coronary arteriography and left ventricular ejection fraction

Coronary arteriography and left ventriculography
were performed on 93 of 100 MI patients and on 25 of 44 angina pectoris patients. A fixed narrowing of more than 75% of the luminal diameter was defined as significant coronary artery stenosis. According to this criterion, 50 and 43 MI patients were found to have single-vessel and multi-vessel disease, respectively, and 12 and 13 angina pectoris patients, single-vessel and multi-vessel disease, respectively.

The left ventricular ejection fraction was calculated by the area-length method from left ventriculograms obtained in right anterior oblique projection.

5. Statistical analysis of data

All data were expressed as mean ± standard deviation. Comparisons between groups were made by Chi-square analysis for discrete variables and unpaired t-test for continuous variables. Differences were considered statistically significant when p < 0.05.

RESULTS

Personal and psychological tests

In Fig. 1 the scores made with the E scale are shown. The left panel of Fig. 1 shows the mean E scores (30 ± 10 for group A, 28 ± 12 for group B, 24 ± 7 for group C, 23 ± 8 for group D and 29 ± 9 for the control group) of group A were significantly higher than those of group D (p < 0.01), and those of groups C and D were significantly lower than those of the control group (p < 0.05 for both groups C and D). The mean E scores for angina pectoris without a history of MI were 23 ± 13 for group E and 35 ± 7 for group F, as shown on the right panel of Fig. 1. The scores of the F group and control group were significantly higher than those of group E (p < 0.01, p < 0.05, respectively).

In Fig. 2 the scores made with the N scale are shown. As shown on the left panel of Fig. 2, the mean N scores for MI were 12 ± 9 for group A, 7 ± 6 for group B, 19 ± 11 for group C, 17 ± 9 for group D and 9 ± 6 for the control group. The N scores of group D were significantly higher than those of group A, B and control groups (p < 0.05, p < 0.001, p < 0.05, respectively), while the N scores of the B group and control group were significantly lower than those of group C (p < 0.01 for both B and control groups). The mean N scores for angina pectoris without a history of MI were, as shown on the right panel of Fig. 2, 15 ± 10 for group E and 7 ± 7 for group F. The N scores of group E were significantly higher than those of the F and control groups (p < 0.05 for both F and control groups).

Tables 1 and 2 summarize the characteristics of
Table 1. Clinical features of each group of patients with myocardial infarction.

<table>
<thead>
<tr>
<th></th>
<th>Group A (%)</th>
<th>Group B (%)</th>
<th>Group C (%)</th>
<th>Group D (%)</th>
<th>p value A vs B</th>
<th>A vs C</th>
<th>A vs D</th>
<th>B vs C</th>
<th>B vs D</th>
<th>C vs D</th>
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<tbody>
<tr>
<td>Number of cases</td>
<td>40</td>
<td>20</td>
<td>14</td>
<td>26</td>
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<tr>
<td>Age (years)</td>
<td>58±11</td>
<td>62±9</td>
<td>60±10</td>
<td>62±8</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>A history of previous angina</td>
<td>20(50)</td>
<td>10(50)</td>
<td>11(79)</td>
<td>21(81)</td>
<td>NS</td>
<td>NS</td>
<td>&lt;0.05</td>
<td>NS</td>
<td>&lt;0.05</td>
<td>NS</td>
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<tr>
<td>Risk factors*</td>
<td>21(53)</td>
<td>12(60)</td>
<td>10(71)</td>
<td>15(58)</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
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<tr>
<td>Site of myocardial infarction</td>
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<td></td>
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<td></td>
<td></td>
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<tr>
<td>Anterior</td>
<td>16(40)</td>
<td>5(25)</td>
<td>0(0)</td>
<td>9(35)</td>
<td>NS</td>
<td>&lt;0.01</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Inferior</td>
<td>12(30)</td>
<td>5(25)</td>
<td>9(64)</td>
<td>5(19)</td>
<td>NS</td>
<td>NS</td>
<td>&lt;0.05</td>
<td>NS</td>
<td>&lt;0.01</td>
<td>NS</td>
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<tr>
<td>Extensive</td>
<td>12(30)</td>
<td>10(50)</td>
<td>5(36)</td>
<td>12(46)</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
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<tr>
<td>Number of diseased coronary arteries</td>
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<td></td>
<td></td>
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<tr>
<td>Single vessel</td>
<td>23(59)</td>
<td>9(47)</td>
<td>11(92)</td>
<td>7(30)</td>
<td>NS</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>NS</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Multi-vessel</td>
<td>16(41)</td>
<td>10(53)</td>
<td>18(8)</td>
<td>18(70)</td>
<td>NS</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>NS</td>
<td>&lt;0.01</td>
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<tr>
<td>LVEF (%)</td>
<td>48±17</td>
<td>47±14</td>
<td>57±12</td>
<td>54±12</td>
<td>NS</td>
<td>&lt;0.05</td>
<td>NS</td>
<td>&lt;0.05</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Mean maximum ST-depression (mm)</td>
<td>1.6±0.8</td>
<td>1.8±0.7</td>
<td>—</td>
<td>—</td>
<td>NS</td>
<td>—</td>
<td>—</td>
<td>—</td>
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<td>—</td>
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<tr>
<td>CMI</td>
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<tr>
<td>Subgroups I and II</td>
<td>31(78)</td>
<td>17(85)</td>
<td>17(85)</td>
<td>12(46)</td>
<td>NS</td>
<td>&lt;0.01</td>
<td>&lt;0.05</td>
<td>&lt;0.01</td>
<td>&lt;0.05</td>
<td>NS</td>
</tr>
<tr>
<td>Subgroups III and IV</td>
<td>9(22)</td>
<td>3(15)</td>
<td>13(93)</td>
<td>14(54)</td>
<td>NS</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

CMI, Cornell Medical Index; LVEF, Left ventricular ejection fraction; NS, not significant, Groups A, B, C and D are described in Fig. 1. *Risk factors: hypertension, diabetes mellitus, hyperlipidemia

Table 2. Clinical features of each group of patients with angina pectoris without a history of myocardial infarction.

<table>
<thead>
<tr>
<th></th>
<th>Group E (%)</th>
<th>Group F (%)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of cases</td>
<td>31</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>60±7</td>
<td>60±11</td>
<td>NS</td>
</tr>
<tr>
<td>Risk factors*</td>
<td>18(58)</td>
<td>5(39)</td>
<td>NS</td>
</tr>
<tr>
<td>Number of diseased coronary arteries</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single vessel</td>
<td>3(43)</td>
<td>9(50)</td>
<td>NS</td>
</tr>
<tr>
<td>Multi-vessel</td>
<td>4(57)</td>
<td>9(50)</td>
<td></td>
</tr>
<tr>
<td>LVEF</td>
<td>62±10</td>
<td>65±8</td>
<td>NS</td>
</tr>
<tr>
<td>Mean maximum ST-depression (mm)</td>
<td>1.6±0.5</td>
<td>1.9±0.6</td>
<td>NS</td>
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<tr>
<td>CMI</td>
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<tr>
<td>Subgroups I and II</td>
<td>20(65)</td>
<td>10(77)</td>
<td>NS</td>
</tr>
<tr>
<td>Subgroups III and IV</td>
<td>11(36)</td>
<td>3(23)</td>
<td></td>
</tr>
</tbody>
</table>

CMI, Cornell Medical Index; LVEF, Left ventricular ejection fraction; NS, not significant, Groups E and F are described in Fig. 1. *Risk factors: hypertension, diabetes mellitus, hyperlipidemia.
clinical features of the groups of patients. Assuming CMI to be normal for subgroups I and II and CMI to be positive for neuroticism in subgroups III and IV, the frequency of neuroticism was the highest with group C and the lowest with Group B (22% for group A, 15% for group B, 93% for group C and 54% for group D). There was no significant difference in the frequency of neuroticism between groups A and B, but there was between the other groups. For angina pectoris patients without a history of MI, on the other hand, there was no significant difference in frequencies of subgroups III and IV between groups E and F.

Characteristics of Clinical Features

As shown in Table 1, there was no significant difference in age and risk factor between any groups. The frequency of a history of previous angina was significantly higher in group D than in groups A and B (p < 0.05 for both groups A and B). The incidence of anterior infarction was significantly higher in groups A and D than in group C (p < 0.01, p < 0.05, respectively) and for inferior infarction, higher in group C than in groups B and D (p < 0.05, p < 0.01, respectively).

The frequency of multi-vessel disease was 41% for group A, 53% for group B, 8% for group C and 70% for group D. It was the highest in group D and the lowest in group C. As shown in Table 1, multi-vessel disease was significantly higher in group D than in groups A and C (p < 0.05, p < 0.01, respectively), while it was significantly lower in group C than in groups A and B (p < 0.05 for both groups A and B).

Left ventricular ejection fraction was the highest with group C. The difference between group C and groups A and B was statistically significant (p < 0.05 for both groups A and B). The mean magnitude of maximum ST-segment depression was 1.6 ± 0.8 mm for group B and 1.8 ± 0.7 mm for group D, with no significant difference between the two groups.

Table 2 summarizes the clinical characteristics of angina pectoris patients without a history of MI. There was no significant difference in age, risk factor, multi-vessel lesion, left ventricular ejection fraction or magnitude of ST-segment depression between the two groups.

DISCUSSION

Ambulatory electrocardiographic monitoring was performed in two 24-h sessions under the stable clinical course conditions and the patients who showed the same results in both ambulatory electrocardiographic findings were selected as the subjects of this study. Therefore, it was suggested that the classification based on the episodes of chest pain and myocardial ischemia was reproducible in these patients.

Of 60 non-recent MI patients without chest pain, 20 had silent myocardial ischemia (group B). The clinical characteristics of group B bore a resemblance to those of group D with symptomatic ischemic episodes, there being little if any difference in site of MI, severity of coronary artery lesions or magnitude of maximum ST-segment depression between the two groups. The E score of the MPI, however, tended to be higher in group B than in group D, while the N score was significantly higher in group D than in group B. Further, the frequency of subgroups III and IV in CMI was also significantly higher in group D than in group B. In short, group B lacked subjective symptoms and showed a tendency toward extroversion, but had such clinical characteristics to suggest the severity of the disease. The patients of group B therefore, not only need treatment for silent myocardial ischemia but also behavioral counseling based on a psychological approach.

On the other hand, group D with confirmed symptomatic ischemia had such clinical characteristics suggesting that group D had a much more severe disease than the other 3 groups. More specifically, group D had low E scores and high N scores, and CMI was positive for neuroticism in 14 of 26 patients. Accordingly, a psychosomatic approach is warranted in the treatment of MI in group D because the patients of this group present clinical features suggesting graveness of the disease, both somatic and psychic.

Group C which had chest pain but no transient ST-segment depression presented with clinical features of milder disease than other groups, but group C had significantly lower E scores than those of B and control groups. In short, the patients of
group C could be characterized by neuroticism as well as by introversion. CMI also indicated that 13 of 14 patients of group C had neuroticism. The findings suggest that the patients of group C need counseling from a psychiatrist.

As for angina pectoris without a history of MI, the personality of the patients in group F was characterized by extroversion, while the mental state of the patients of group E was characterized by neuroticism as were the MI patients of groups C and D with subjective symptoms. These findings therefore suggest that the patients of group E not only need treatment for coronary artery disease but also psychotherapy, while those of group F need both treatment for silent myocardial ischemia and behavioral counseling.

The relation of type A behavior to the morbidity and mortality of coronary heart disease is still debated (16—19). Powell and Thoresen (20) followed the survival of MI patients receiving cardiac counseling by a cardiologist and behavioral counseling by a psychiatrist or psychologist in order to determine the usefulness of such counseling in the treatment of MI. As a result, they found that the cardiac mortality for symptomatic MI patients with poor cardiac function was lower after cardiac counseling than after behavioral counseling, while the reverse was the case with asymptomatic MI patients with good cardiac function. These findings suggest that a reduction in type A behavior may exert the greatest protection against coronary death in the patient with good cardiac function.

The Japanese version of MPI was used in the present study because this personality test can easily check patients for both extroversion and introversion irrespective of age. The results which were obtained by MPI should not be identical with those of types A and B behavior although there was a similarity between extroversion of MPI and type A behavior.

The results of the present study seem to support our view that behavioral counseling is warranted in the treatment of silent myocardial ischemia in patients of groups B and F.

The reported findings from the Framingham study (19) indicated that type A behavior is not related to MI or fatal coronary artery disease. On the other hand, it was suggested that uncomplicated angina pectoris occurred with greater frequency in type A subjects as compared with those who are type B.

Our results indicate that group F bore a resemblance to type A behavior, while group E was characterized by introversion and neuroticism. A further prospective follow-up of the two groups with respect to the frequencies of MI would provide clues to the clarification of the relationship between MI and type A behavior. Group D was found to have the most serious MI and psychological condition of all groups. It has been pointed out (21) that the more severe MI is, the more liable the patients are to develop anxiety and depression. Accordingly, it is important that for the best results, the treatment of coronary artery disease be reinforced with psychotherapy in group D.

There are cases like group C, however, where the patient has only a mild MI but is in a serious psychological condition. There are reports (21, 22) that patients in such a condition are driven into a depressive state by disruptions in marital life, occupation or social life before onset of MI so that they are led into true depression by such a serious event as MI. Patients of this kind may be delayed in rehabilitation or returning to the full range of normal activity unless given counseling by a psychiatrist.

In the present study personality and psychological tests were not performed on the subjects before the onset of MI, so that the mechanism of neuroticism in groups C and D still remains to be elucidated. However, this study has provided suggestive evidence that concurrent ambulatory electrocardiographic monitoring and personality and psychological testing are very useful in developing therapeutic strategies for MI patients with neurotic complaints and episodes of chest pain which are commonly encountered in clinical practice. This study was carried out on MI patients in a prolonged stable condition. Therefore, it may be pointed out that the coronary angiographic and ventriculographic findings are not closely reflected in the ambulatory electrocardiographic findings because the former and the latter tests have been carried out on MI patients at separate times with an interval of at least several months. However, it is suggested from these results that a combination of ambulatory electrocardiographic monitoring and personality and
psychological testing are useful in the detection of silent myocardial ischemia and psychiatric disorders at the convalescent stage of MI patients. Further, concurrent performance of the tests is also effective not only in preventing the development of coronary artery disease but also in improving the prognosis of patients with silent myocardial ischemia. For establishing the usefulness of these procedures, it will be necessary to examine the prognostic significance in groups with and without behavioral counseling and psychotherapy.

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