Holter System Electrocardiographic Studies on 617 Cases

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Holter system electrocardiograms were recorded for 617 patients who were treated at the Department of Cardiology, Tokai University Hospital.

In cases of arrhythmia, ventricular premature contraction (VPC) was the most predominant, in 291 cases (69%) out of 423 with arrhythmia, followed by 59 (14%) with supraventricular premature contraction (SVPC), 23 (5.4%) with paroxysmal atrial tachycardia, 17 (4%) with second degree A-V block and 10 (2.3%) with transient atrial fibrillation (AF).

In addition, nine (2.1%) cases of ventricular tachycardia (VT), one (0.2%) of transient ventricular fibrillation (VF) and one (0.2%) of third degree A-V block were found in particularly severe arrhythmia cases.

Six out of nine cases of VT were cases of acute myocardial infarction (AMI) and all died suddenly while in the hospital or after discharge.

Mild or moderate changes in ST-T were often observed even in normal subjects. Of the 617 cases, only 18 (2.9%) showed a significant elevation or depression of ST. Among these, three definitely had variant angina pectoris (Prinzmetal type).

The above results indicate Holter EKGs are very useful for the diagnosis of arrhythmia and can also be used as a means of evaluating the prognosis in some cases, but there still are some problems in connection with its use for the diagnosis of ischemic heart disease except for the diagnosis of variant angina pectoris.

(Key Words: Holter Electrocardiography, Arrhythmias, Ischemic Heart Disease)

INTRODUCTION

From the second half of the 1950s to the 1960s, Holter of the United States taped wave forms of ECGs and devised an apparatus which makes possible reproduction of these taped wave forms at high speeds for the analysis and determination of abnormalities in ECGs (8, 9). This method has since been abbreviated as the Holter ECG.

In recent years, the method of detecting ECG abnormalities by means of this Holter ECG has spread and is being used clinically for (1) detection of arrhythmia (2) and abnormal ST-T changes, and (3) evaluation on the effectiveness of drug administration (2, 4, 5, 11, 12, 17).

However, reports dealing with this method used with a large population of patients at the same medical institution are few, and studies concerning it are far from satisfactory.

The purpose of this paper is to report results of Holter ECG examinations conducted on more than 600 patients at the Tokai University Hospital, and to perform a comparative study with the results obtained by other investigators.

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MATERIALS AND METHOD

The subjects were 617 in- and out-patients who were treated at the Tokai University Hospital from February, 1975 to May, 1979 and who underwent Holter ECG recordings (383 males, and 234 females), with ages ranging from 13 to 92 (means 50.4 year of age).

A Holter System, Model 425 Electrocardiocorder made by the Avionics Co. was used to record ECG for about 20 hours consecutively, and Model 660 Dynamic Electrocardioscanner was used for analysis.

When using Channel 1, the anode was set at the left margin of the sternum in the 5th intercostal space and the cathode at the manubrim. For Channel 2, the anode was set at the position of chest lead V5 and the cathode at the position of lead V1 of the precordial position.

For the reproduction and analysis of ECGs, observations were performed on ECGs reproduced on the oscilloscope at a speed of 120 times the standard ECG recording rate (25mm/sec), and then the speed was slowed down to 60 times and 30 times of the standard when necessary. For particular arrhythmias, detailed observations were performed by our own method (16).

With respect to changes in the ST segment, a rise or fall of 3mm or more was deemed as abnormal even if the patient's diary showed no mention of chest pain or precordial oppression on that day.

The patients were instructed to write down accurately the time of eating, smoking, physical exercise, urination, defecation, retiring, awakening and appearance of subjective symptoms in his or her diary during the period of EKG recording.

RESULTS

Table 1 shows the comparison between cardiovascular symptoms mentioned in the patient's diary in each case and abnormal findings obtained from the Holter ECG. The extreme sinus bradycardia in the Table refers to bradycareia of 40/min or less. Since one case sometimes had more than two cardiovascular symptoms or more than two ECG findings, the total exceeded 617.

In the case of arrhythmia, the incidence was high for ventricular premature contraction (VPC), accounting for 291 (69%) out of 423 cases of arrhythmia, followed by 59 (14%) with supraventricular premature contraction (SVPC), 23 (5.4%) with paroxysmal atrial tachycardia, 17 (4%) with second degree A-V block and 10 (2.3%) with transient atrial fibrillation (AF).

Among serious cases of arrhythmia there were nine cases of ventricular tachycardia (VT, 2.1%) found by the Holter ECG taken at the time of admission; six of these were acute myocardial infarction (AMI). Fig. 1 (A, B) shows the 12-lead ECG (A) and Holter ECG during VT (B) in one of these cases.

In other types of critical arrhythmia, transient ventricular fibrillation (VF, Fig. 2) and third-degree A-V block were found in out-patients.

Among the cardiovascular symptoms of arrhythmia from the patients'
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In Holter ECGs, there were several cases of irregular pulse (16 cases) and palpitation (15 cases). As a whole, however, few mentioned symptoms and there were many asymptomatic cases (81%). Out of 291 cases of VPC in particular, as many as 266 cases (91%) mentioned no symptoms in their diaries.

In the case of ST-T changes, 18 cases (2.9%) showed significant elevation or depression of ST segments. Of these, three cases showed a rise in the ST segment. Changes in the ECG in one of these cases are shown in Fig. 3. ST depression was noted in 15 cases.

Among the subjective symptoms of angina pectoris, chest pain accounted for the most (44%), followed by cases mentioning no symptoms (33%) and cases of other symptoms (difficulty in breathing or shoulder pain).

In addition, there were relatively rare cases of tachycardia-dependent transient left bundle branch block (Fig. 4), transient WPW syndrome (Fig. 5) and a short run type of VT in cases without organic heart disease in various tests (Fig. 6).

**Table 1.** Cardiovascular symptoms and abnormal findings in Holter ECGs among 617 cases at the Tokai University Hospital

Since one case sometimes had more than two cardiovascular symptoms in ECG findings, the grand total exceeds 617.

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Chest pain</th>
<th>Precordial oppression</th>
<th>Palpitation</th>
<th>Irregular pulse</th>
<th>Others</th>
<th>No of symptoms</th>
<th>Total</th>
</tr>
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<tbody>
<tr>
<td>SVPC</td>
<td></td>
<td></td>
<td>3</td>
<td>5</td>
<td>2</td>
<td>49</td>
<td>59</td>
</tr>
<tr>
<td>VPC</td>
<td>1</td>
<td></td>
<td>2</td>
<td>5</td>
<td>10</td>
<td>7</td>
<td>266</td>
</tr>
<tr>
<td>Paroxysmal SVT</td>
<td>1</td>
<td></td>
<td>4</td>
<td>4</td>
<td>14</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>VT</td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>Transient AF</td>
<td>1</td>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>7</td>
<td>10</td>
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<tr>
<td>Transient VF</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
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<tr>
<td>Sinus arrest</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>S-A block</td>
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<td>3</td>
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<tr>
<td>Extreme sinus bradycardia</td>
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<td></td>
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<td></td>
<td></td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>2nd A-V block</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>15</td>
<td>17</td>
<td></td>
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<tr>
<td>3rd A-V block</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
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<td>A-V dissociation</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>2</td>
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<tr>
<td>Transient LBBB</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td>2</td>
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<tr>
<td>Transient RBBB</td>
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<td></td>
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<td></td>
<td></td>
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<td>1</td>
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<tr>
<td>Transient WPW</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td>1</td>
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<tr>
<td>ST elevation</td>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>ST depression</td>
<td>7</td>
<td></td>
<td>3</td>
<td></td>
<td>5</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>6</td>
<td>4</td>
<td>8</td>
<td>1</td>
<td>10</td>
<td>32</td>
<td>61</td>
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<tr>
<td>No abnormal findings</td>
<td>16</td>
<td>12</td>
<td>19</td>
<td>3</td>
<td>20</td>
<td>154</td>
<td>224</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>32</strong></td>
<td><strong>19</strong></td>
<td><strong>42</strong></td>
<td><strong>20</strong></td>
<td><strong>52</strong></td>
<td><strong>565</strong></td>
<td><strong>730</strong></td>
</tr>
</tbody>
</table>
Fig. 1 One myocardial infarction case with ventricular tachycardia (VT) A shows 12-lead ECG recorded in acute phase. B shows two parts of Holter ECG recorded 6 months after the onset of myocardial infarction. VT (indicated by arrow) occurred at 2:00 am. However no mention of cardiovascular symptoms was found in his diary.
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Fig. 2  One case with ventricular fibrillation (VF) and depression in ST segment
A shows no abnormal findings, but apparent ST depression appeared 2 min later (B). Soon after transient VF (indicated by arrow) occurred suddenly (C). About 4 min. after the VF, ECG was approximately normal (E).

Fig. 3  One case with Prinzmetal's angina pectoris (variant form)
A shows a gradually elevated ST segment. The patient suffered from precordial oppression consistent with these findings and woke up. At the end of ST elevation, ventricular premature contraction (indicated by arrow) is demonstrated.
Fig. 4  One case of intermittent left bundle branch block
Heart rates were 52 beats per min at 4:35 AM (A) and intraventricular conduction disturbances were not observed at that time. However, when heart rates increased to 65 beats per min. at 2:25 PM (B), complete left bundle branch block appeared. This phenomenon is called "rate-dependent" left bundle branch block.

Fig. 5  One case with transient WPW syndrome
The first two, 5th to 7th, 9th to 12th and the last beats of A show normal A-V conduction rhythm and this is the usual conduction of this patient. However, the findings of a short PR interval and prolonged QRS interval due to a delta wave (initial slurring of the QRS deflection) are demonstrated in the 3 to 4th, 8th and 13th to 14th beats of 1 and in all beats of B.
DISCUSSION

The major advantage of Holter ECG is that ECG abnormalities liable to be overlooked by the short-term ECG recording, such as the standard 12-lead at rest, can easily be detected. This ECG is said to be effective particularly for the diagnosis of arrhythmia and ischemic heart disease (IHD) (1, 2, 4, 11, 12). Therefore, it is no exaggeration to say that the use of the Holter ECG is centered on the detection of these two disorders.

In arrhythmia cases, the incidence of VPC and SVPC was high in the subjects studied in the present investigation. The incidence was 62.2% for VPC and 76% for SVPC in 301 cases of Hinkle et al (7) and 55% for VPC and 54% for SVPC in the cases of Arai et al (1). In our cases, there were slightly more cases of VPC but considerably fewer cases of SVPC when compared with the previous two reports.

We have been studying ventricular arrhythmia from various aspects for the past several years (13, 14, 15, 16) and have consequently accumulated many cases. This probably explains why more cases of VPC were found in our work.

With this type of ECG, it is more difficult to detect SVPC than VPC because transient sinus tachycardia or respiratory arrhythmia, which is often observed in normal people, is diagnosed erroneously as SVPC during reproduction and analysis of ECGs at high speeds.

When SVPC was indicated by a computer, we confirmed it at the standard ECG recording speed (2.5 cm/sec) and excluded cases of transient sinus tachycardia and respiratory arrhythmia or cases with extremely low
incidence of SVPC from cases of SVPC. That is probably why there were fewer cases of SVPC in our experience than in the two previous reports.

Among other types of arrhythmia, there were paroxysmal atrial tachycardia and transient AF, but unexpectedly both showed few clinical symptoms. These paroxysmal ECG abnormalities often occurred during sleep at night and, the patients were not aware of the symptoms or they were aware of them but would not take the trouble of writing them down in the diary at night. That is probably the reason for few statements concerning clinical symptoms.

Among the serious types of arrhythmia there were VT, transient VF, sinus arrest and third degree A-V block. Six of these cases of VT without cardiovascular symptoms were all recorded at the time of admission for AMI and complicated heart failure. Three of them died of VF during hospitalization and the remaining three were so improved that they were discharged, but during follow-up in the out-patient clinic, they died suddenly on the street, while watching the folk song training or while viewing TV.

Therefore, cases of myocardial infarction were all required to undergo continual ECG recordings for many hours and it appears important to follow the clinical course carefully for cases which once showed VT.

Changes in ST-T in Holter ECGs are said to be influenced greatly by the recorder and the posture (6, 10). At present, therefore, Holter ECGs appear to be less useful in the diagnosis of IHD than in the diagnosis of arrhythmia.

However, Stern et al (11) reported that ST-T changes in Holter ECGs can predict accurately the abnormalities of radiographic findings of the coronary artery, while there is a report by Arai et al (1) stating that since there is a difference in the ST-trend between ST-T changes considered attributable to a change in the posture and ST-T changes due to anginal attacks during sleep at night, pseudo-positive ST-T changes arising from a change in the posture can be avoided.

We often saw changes of 1-2mm in ST-T in the course of routine reproduction and analysis of Holter ECGs, regardless the patients' age. Therefore, we did not regard them as significat ST-T changes and made no diagnosis of angina pectoris unless attacks such as chest pain were mentioned in the diary. There were very few cases of ST-T change, only 18 of the subjects in this study, probably because of such a sctict criterion for diagnosis. However, this criterion for diangosis still presents some problems and it is necessary to perform further studies in the future.

In three cases of abnormal rise in ST, a paroxysmal rise in ST was observed 1-4 times during sleep at night and there was chest pain, precordial discomfort or precordial oppression consistent with the rise in ST. That is the reason why these cases were diagnosed as the Prinzmetal type of variant angina pectoris.

These three patients had suffered from anginal attacks at night for a long period of time, and some of them were diagnosed as neurocirculatory asthenia or neurosis and received treatment at various medical institutions.

As pointed out by other investigators (1, 11, 12), this type of ECG is very effective for diagnosis of angina pectoris, particularly variant angina...
pectoris. With respect to ST depression, Stern et al (11) considered a case as positive when 1mm or more of ST deviation horizontal or downward continued for more than 80msec or there were inverted T waves.

In evaluating cases we did not use this criterion as an index, but our impression concerning the diagnosis of effort angina pectoris was rather high when exercise testing such as Master’s test was used concomitantly.

However, the Holter ECG is effective in the acute phase of heart disease of impending infarction for which exercise testing is contraindicated.

Evaluation of abnormalities in ST-T changes varies somewhat from one institution to another as described above. At present, research on machines capable of preparing a ST-T trend program easily and accurately is promoted in Japan (5). Therefore, prospects are bright that the effectiveness of this ECG for diagnosis of IHD will be further enhanced.

REFERENCES
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