THE TOTAL HEART BEATS PER 24 HOURS BY AMBULATORY ELECTRO-CARDIOGRAPHY AND THE CHANGES OF HEART RATE BY TREADMILL EXERCISE TEST IN SICK SINUS SYNDROME

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To study the clinical implications of the total number of heart beats per 24 hours (THB), 24 hour ambulatory electrocardiography and treadmill test were performed by sixty patients with sick sinus syndrome (SSS, 58 ± 12 years old) who underwent overdose suppression test. Results were compared with thirty control subjects (58 ± 12 years old).

The THB was 74 ± 11 thousand beats in the SSS group and 99 ± 10 thousand beats in the control group. The THB and the maximal heart rate (MHR) achieved during the treadmill test were significantly lower in the SSS group than in the control group. However, the exercise duration in patients with SSS was similar to that of the control subjects. The exercise duration and the MHR were correlated to age, but not to the THB in the patients with SSS. There was no significant relationship between the total heart beats per 24 hours and the maximal sinus node recovery time (max. SNRT).

We conclude that the THB, independent of the max. SNRT, can be a useful index in diagnosing and assessing the quantity of bradycardia in patients with SSS. The tolerance of exercise and the MHR were not correlated with the THB, in patients with SSS.

It is difficult to evaluate the severity of the sick sinus syndrome by routine electrocardiography alone. The heart rate is variable because of the influence of multiple factors during daily activities. The heart rates recorded by routine electrocardiography over 3 to 5 min can be influenced by temporary factors such as exercise or emotin. The total number of heart beats obtained by ambulatory electrocardiography for 24 hours can be a useful parameter in evaluating the severity of bradycardia.

The methods available to assess the severity of the sick sinus syndrome have been reported as the sinus node recovery time (SNRT)1–5 and the response of the heart rate to exercise6–9. There is a relationship between the length of the maximal SNRT and symptoms of cerebral ischemia. However, the precise prevalence with which the SNRT is abnormal in patients with sinus node dysfunction is uncertain and it does not necessarily reflect the severity of the clinical symptoms.

On the other hand, the response of the heart rate to exercise reflects physical activity and exercise tolerance. Patients with sinus node dysfunction are unable to attain an adequate

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increase in heart rate or oxygen uptake when compared to age- and sex-matched control subjects? The exercise test is used for the evaluation of sinus node activity in response to increased physical stress for differentiation of the sick sinus syndrome from physiological sinus bradycardia.\(^8\)\(^9\)

To the best of our knowledge, the relationship between the total number of heart beats per 24 hours and the change of heart rate with exercise in sick sinus syndrome has not been reported.

To study the clinical implications of the total number of heart beats per 24 hours, the present study included (1) a comparison of the total number of heart beats per 24 hours in patients with sick sinus syndrome and age- and sex-matched control subjects; (2) the relationship between the total number of heart beats per 24 hours and the maximal SNRT in patients with sick sinus syndrome; (3) the relationship between the total number of heart beats per 24 hours and the response of the heart rate to treadmill exercise in patients with sick sinus syndrome and in control subjects.

Subjects and Methods

The subjects were 60 patients with sick sinus syndrome who underwent ambulatory electrocardiography, treadmill test and electrophysiological test at The Third Department of Internal Medicine, Nagasaki University Hospital from May 1974 through December 1986. Twenty two were men and 38 were women; their ages ranged from thirty to seventy six years with a mean age of 57.7 years. Twenty-nine of the patients were symptomatic, suffering from one or more the following: weakness, dizziness, faintness and syncope.

For our study, we used the classification of Rubenstein\(^10\) dividing the sixty patients with sick sinus syndrome into 3 groups as follows. Group I consisted of 14 patients with persistent and otherwise unexplained sinus bradycardia at a heart rate of less than 50 beats per minute on the resting electrocardiogram. Group II consisted of 24 patients with at least one documented episode of sinus arrest or sinoatrial block. Group III consisted of 22 patients with bradycardia-tachycardia syndrome. In addition, the maximal SNRT of all patients with sick sinus syndrome was more than 1.5 seconds.

The 30 control subjects were selected from in-patients who underwent ambulatory electrocardiography and a treadmill exercise test and showed no apparent sinus bradycardia or sinoatrial block on several routine electrocardiograms during admission. No abnormality of lungs, thyroid functions or musco-skeletal system were noted. The control subjects were 11 men and 19 women; their age ranged from 28 years to 77 years with a mean age of 57.5 years.

Patients with sick sinus syndrome and in the control subjects received no drugs that might affect the heart rate during the period of this study.

Ambulatory electrocardiography

More than one ambulatory electrocardiography was done in the patients with sick sinus syndrome and the control subjects. The optimal tapes that had records of adequate diagnostic quality were chosen for the measurement. For this study, the tapes in Group III were measured only if they had records without supraventricular tachycardia.

Twenty-four hour ambulatory electrocardiography was performed using a portable two channel tape recorder (Avionics Model 445B) to obtain a two-lead ECG corresponding to V\(_1\) and V\(_5\). The tapes were played back on a 660A or 9000 Avionics System. The total heart beats per 24 hours and per every one hour were obtained by automatic count. The maximal and minimal heart rates during the 24 hours were measured on the trend recording and verified by obtaining an ECG at 25 mm/sec. The total heart beats during a daytime period and a nighttime period were measured by the total heart beats during the 6 hours from 12 : 00 p.m. to 6 p.m. and from 0 a.m. to 6 a.m., respectively. All patients with sick sinus syndrome and the thirty control subjects were admitted during the ambulatory Holter monitoring.

Treadmill tests

All patients with sick sinus syndrome and all the control subjects exercised on the treadmill (Case type, Marquette) until symptoms developed using a modified Bruce protocol.\(^11\) The observation and recording of the heart rate began 3 min before exercise, and continued during exercise and for 10 min after exercise, during which time the patients were sitting. The following variables were obtained from the treadmill exercise test: the resting heart rate before exercise, the heart rate at each exercise level, the maximum heart rate achieved during exercise, the maximum duration of exercise, and the decreasing ratio of the heart rate after exer-
TABLE I TOTAL HEART BEATS, THE DIFFERENCE BETWEEN DAY AND NIGHTTIME, MAXIMAL AND MINIMAL HEART RATE, AND MAXIMAL SINUS NODE RECOVERY TIME IN PATIENTS WITH SICK SINUS SYNDROME AND CONTROL GROUP

<table>
<thead>
<tr>
<th>Age</th>
<th>Total number of heart beats</th>
<th>Difference between day and night</th>
<th>Maximal observed heart rate (beats/min.)</th>
<th>Maximal SNRT (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>per 24 hours</td>
<td>Day per 6 hours</td>
<td>Night</td>
<td>day and night</td>
</tr>
<tr>
<td>Group I</td>
<td>(n = 14)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>56</td>
<td>70491</td>
<td>± 6781</td>
<td>± 1977</td>
<td>± 15293</td>
</tr>
<tr>
<td>n = 24</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group II</td>
<td>(n = 24)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>55</td>
<td>71771</td>
<td>± 2921</td>
<td>± 2977</td>
<td>± 15310</td>
</tr>
<tr>
<td>Group III</td>
<td>(n = 22)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>61</td>
<td>80976</td>
<td>± 15471</td>
<td>± 3017</td>
<td>± 3469</td>
</tr>
<tr>
<td>Whole SSS</td>
<td>(n = 60)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>58</td>
<td>74707</td>
<td>± 10942</td>
<td>± 3017</td>
<td>± 21971</td>
</tr>
<tr>
<td>Control</td>
<td>(n = 30)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>58</td>
<td>98509</td>
<td>± 2987</td>
<td>± 2531</td>
<td>± 4259</td>
</tr>
</tbody>
</table>

Difference between day and night = the difference in the total heart beats between 6 daytime and 6 nighttime hours; Maximal observed heart rate = maximum heart rate during 24 hours; Minimal observed heart rate = minimum heart rate during 24 hours; Maximal SNRT = maximal sinus node recovery time. Group I = persistent sinus bradycardia; Group II = sinoatrial block or sinus arrest; Group III = bradytachy syndrome. All values are the mean ± standard deviation. +: p < 0.025; ++: p < 0.01; *: p < 0.005.
Fig.2. The relationship between the total heart beats per 24 hours and the maximal sinus node recovery time in patients with sick sinus syndrome.

**TABLE II**

<table>
<thead>
<tr>
<th>Age (min.)</th>
<th>M.H.R. (bpm)</th>
<th>D.</th>
<th>M.H.R. (bpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Group H</td>
<td>65 ± 13.8</td>
<td>119.8± 11.6</td>
<td>76.4± 14.2</td>
</tr>
<tr>
<td>Group M</td>
<td>65 ± 10.3</td>
<td>123.2± 12.7</td>
<td>72.6± 14.2</td>
</tr>
<tr>
<td>Group L</td>
<td>58 ± 9.9</td>
<td>124.9± 12.9</td>
<td>69.3± 14.2</td>
</tr>
<tr>
<td>Control</td>
<td>62 ± 9.9</td>
<td>123.2± 12.9</td>
<td>67.6± 14.2</td>
</tr>
</tbody>
</table>

vanced through the right basilic or right femoral vein and positioned high in the right atrium adjacent to the junction of the superior vena cava. The patient then underwent atrial pacing for 2-min periods at pacing rates of 90, 110, 130, 150, 180 and 210 beats per minute. A temporary pacemaker (Cardiac Stimulator, Nihon Koden) was utilized; this produced rectangular stimuli of 2-msec duration at twice diastolic threshold. Sinus node recovery times were measured from the last paced P wave to the patient's first beat after the abrupt cessation of atrial pacing.

Statistical analysis was performed using the unpaired Student’s t test.

**RESULTS**

1) 24-Hour Ambulatory Electrocardiography:

The total heart beats per 24 hours, the total number of heart beats during the 6 daytime hours and the 6 nighttime hours, the difference between the 6 daytime and 6 nighttime hours,

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was significantly higher in Group III than in Group I or II. Twenty-two patients in Group III had no tachyarrhythmias during ambulatory electrocardiography monitoring, but the total heart beats per 24 hours of 5 patients (23%) in Group III was more than ninety thousands beats.

**Total Heart Beats during the 6 Daytime and 6 Nighttime Hours**

In all of the sick sinus syndrome patients, the total heart beats during the 6 daytime hours (12 p.m. to 6 p.m.) and the 6 nighttime hours (0 a.m. to 6 a.m.) were 20 ± 3 thousand beats and 16 ± 2 thousand beats, respectively (Table I).

The total heart beats during the 6 daytime hours were 19 ± 2 thousand in Group I, 19 ± 3 thousand in Group II and 21 ± 4 thousand in Group III. The total heart beats during the 6 nighttime hours were 15 ± 1 thousand beats in Group I, 15 ± 2 thousand beats in Group II and 18 ± 3 thousand beats in Group III. In the control group, the total number of heart beats during the 6 daytime and 6 nighttime hours were 27 ± 3 thousand beats and 22 ± 3 thousand beats, respectively. The total heart beats of both the daytime and the nighttime interval were significantly different between the group of all sick sinus syndrome patients and the control group (p < 0.005). Among the 3 groups of sick sinus syndrome patients, the total heart beats in the daytime intervals were not significantly different, but the total heart beats in the nighttime intervals was significantly higher in Group III than in either Group I or Group II (Group III vs I; p < 0.025, Group III vs II; p < 0.005).

The differences in the total heart beats between the daytime and nighttime intervals was 4.0 ± 1.4 thousand beats in Group I, 4.0 ± 1.5 thousand beats in Group II, 3.8 ± 2.7 thousand beats in Group III, 3.6 ± 1.6 thousand beats in the all sick sinus syndrome patients, and 4.9 ± 2.0 thousand beats in the control group. There were no significant differences among the 3 groups of sick sinus syndrome patients, but the mean was significantly lower in all sick sinus syndrome patients together than in the control group (p < 0.005).

**Total Heart Beats per 24 Hours and Maximal SNRT** (Fig. 2).

The maximal SNRT was 2.11 ± 0.72 sec in Group I, 4.09 ± 2.09 sec in Group II, and 3.44 ± 1.60 sec in Group III. The maximal SNRT in Group I was significantly shorter than that of

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Fig. 3. Exercise duration and maximum heart rate achieved during exercise in patients with sick sinus syndrome.

Duration: exercise duration, M.H.R.: maximal heart rate achieved during exercise, N.S.; not significant

Three groups were identified according to the total heart beats per 24 hours

~7; Group L (n = 24): total heart beats was less than 7 x 10^4 beats per 24 hours.

7~9; Group M (n = 31): total heart beats was between 7 x 10^4 and 9 x 10^4 beats per 24 hours.

9~; Group H (n = 5): total heart beats was more than 9 x 10^4 beats per 24 hours. C; Control group (n = 30).

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the maximal and minimal observed heart rates and the maximal SNRT are shown in Table I.

**Total Heart Beats per 24 Hours**

The total heart beats per 24 hours in the 3 groups of sick sinus syndrome patients and in the control group are shown in Fig. 1 and Table I.

The total heart beats per 24 hours was 70 ± 7 thousand beats in Group I (n = 14); 71 ± 9 thousand beats in Group II (n = 24); 80 ± 15 thousand beats in Group III (n = 22) and 99 ± 10 thousand beats in the control group (n = 30). The total heart beats per 24 hours in the 3 groups of sick sinus syndrome patients was significantly lower than that of the control group (p < 0.005). The total heart beats per 24 hours

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Groups II and III. There was no significant correlation between the total number of heart beats per 24 hours and maximal SNRT (n = 60, r = -0.10, N.S.).

2) Treadmill exercise test

The age, maximal exercise duration, maximal heart rate achieved during exercise, heart rate at each exercise level and decreasing ratio after exercise are shown in Table II. The average age was 65 ± 7 in Group H (more than 90 thousands beats per 24 hours; n = 5), 59 ± 10 in Group M (70–90 thousands beats per 24 hours; n = 31), 55 ± 14 in Group L (less than 70 thousands beats per 24 hours; n = 18) and 58 ± 12 in the control group (n = 30), respectively. The differences in the above ages were not significant.

Reasons for Terminating Exercise

Of the 60 patients with sick sinus syndrome, fatigue occurred in 56, dizziness related to maximal stress in one, and marked depression of the S-T segment (more than 2.0 mm) developed in one. The other 2 patients were asymptomatic when they achieved 90 percent of their maximum predicted heart rate, and exercise was terminated. Of the 30 subjects in the control group, fatigue occurred in 15. The other 15 subjects in the control group were asymptomatic when they achieved 90 percent of their maximum predicted heart rate, and exercise was terminated. All patients except 4 patients with sick sinus syndrome and 2 control subjects achieved at least the fourth stage of the modified Bruce protocol.

The Response of Heart Rate to Exercise

The maximum exercise duration and maximum heart rate achieved during exercise are shown in Fig. 3.

The maximum exercise duration was 13.8 ± 1.6 min in Group H, 13.2 ± 2.2 min in Group M, 14.3 ± 2.9 min in Group L and 13.1 ± 2.5 min in the control group. The maximum exercise duration was not significantly different among the 4 groups.

Maximum heart rate achieved during exercise was 119.8 ± 22.7 beats per minute in Group H, 120.5 ± 24.5 beats per minute in Group M, 116.6 ± 23.1 beats per minute in Group L, and 138.2 ± 22.0 beats per minute in the control group. The maximum heart rates achieved during exercise were not significantly different among the 3 groups of patients with sick sinus syndrome. However, the rates were significantly different between the patients with sick sinus syndrome and the control group.

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| Table III: Age and Treadmill Exercise Test in Patients with Sick Sinus Syndrome |
|-------------------------|--------|----------------|----------|
|                         | D (min.) | M.H.R. (bpm.) | Post exercise |
|                         |         |                | Decreasing ratio (%) |
|                         |         |                | 2        |
|                         | 1       | 2              | 10 min.  |
| Stage 0                | 52.6    | 69.4           | 76.6     |
| (min.)                 | ± 6.9   | ± 12.3         | ± 14.2   |
| Group A (n = 14)       | 123.9   | 122.0          | 125.7    |
| Group B (n = 34)       | 102.1   | 102.7          | 104.1    |
| Group C (n = 12)       | 111.3   | 112.4          | 113.3    |

Group A = 49 years old or younger; Group B = 50–69 years old; Group C = 70 years old or older; other abbreviations as in Table II.

Fig. 5. Exercise duration and maximal heart rate achieved during exercise. Three groups of patients with sick sinus syndrome divided by age.

~49: Group A (n = 14): patients were 49 years old or younger, 50–69: Group B (n = 34): patients were from 50 to 69 years old, 70+: Group C (n = 12): patients were 70 years old or older.

syndrome as a whole and the control group (p < 0.005, Fig. 3).

The heart rate at rest before exercise and the response of heart rate to the fourth stage are shown in Fig. 4a and Table II. All patients except 3 in Group M and one patient in Group L achieved at least the fourth stage. The mean difference between the resting heart rate and the heart rate at the end of the fourth stage (I.H.R.) was 33.0 ± 6.6 beats per minute in Group H, 44.0 ± 17.6 beats per minute in Group M, 41.7 ± 13.3 beats per minute in Group L, and 45.1 ± 13.9 beats per minute in the control group. There was no significant difference between the control group and Group M or L. However, the I.H.R. in Group H was significantly different from the control. The heart rates at rest and at each exercise stage were significantly lower in all patients with sick sinus syndrome than in the control group with the exception of the resting heart rates in Group H (p < 0.05~
The Response of Heart Rates after Exercise

The decreasing ratios after exercise are shown in Fig. 4b and Table II. The ratios increased rapidly following termination of exercise in Group H, Group M, Group L and the control group. This trend persisted for the first 3 min, and then reached a plateau after 5 min. The ratios were not significantly different among the 4 groups.

The Response of Heart Rate of Exercise and Age (Table III)

The exercise duration and maximum heart rate achieved during exercise, heart rate at each exercise level and decreasing ratio after exercise are shown in Fig. 5 and Table III. The exercise duration was 15.6 ± 3.4 min in Group A (49 years old or younger; n = 14), 13.7 ± 2.5 min in Group B (50–69 years old; n = 34), and 11.3 ± 2.6 min in Group C (70 years old or older; n = 12). The exercise duration was significantly longer in Group A than in Group C (p < 0.05). The maximum heart rate was 123.9 ± 25.3 beats per minute in Group A, 122.0 ± 21.7 beats per minute in Group B, and 104.1 ± 21.3 beats per minute in Group C. The maximum heart rate was higher in Group A than Group C (p < 0.05). Both the exercise duration and the maximum heart rate were negatively correlated with aging.

The heart rates at rest and at each exercise level were not significantly different among the 3 groups (Table III). In the decreasing ratios after exercise, Group A showed a significantly more rapid deceleration of the heart rate than did Group C. With aging, both the exercise duration and the maximum heart rate achieved were lower, while the deceleration of the heart rate after exercise was slower.

DISCUSSION

Many reports on the sick sinus syndrome have been published, but most of them have been about the clinical classification, sinus node recovery time, or therapy by pacemaker implantation. In this study, we evaluated the clinical implications of the total heart beats per 24 hours by ambulatory Holter monitor recording, and investigated the relationship between this parameter and the changes in the heart rate with the treadmill exercise test in patients with sick sinus syndrome.

Average Heart Rate

In normal subjects, Brodsky reported that the average heart rate for 24 hours in 50 male medical students (range 23 to 27 years old) without apparent heart disease was 73 ± 7 beats per minute. In Kostis' study the average heart rate for 24 hours was 78.9 ± 8.8 beats per minute in 101 subjects with no heart disease (average age 48.8 years old, range 16 to 68 years old). On the other hand, the average heart rate for 24 hours in the control group of our study was 68.7 ± 6.6 beats per minute. The average heart rate for 24 hours was lower in our control group than in the above 2 studies because of the older average age of our control group (58 ± 12 years old). The average heart rate during 6 hour daytime interval in our control group was 73.6 beats per minute, as opposed to 80 beats per minute in Brodsky's study and 84.2 beats per minute in Kostis' report. The average heart rate of the 6 hour nighttime interval in our control group was 61.0 beats per minute, as opposed to 56 beats per minute in Brodsky's study and 70.0 beats per minute in Kostis' report.

There have been only a few studies on the averaged heart rate. The effect on sinus rhythm and automaticity of complete digitalization in patients with sick sinus syndrome, in a 24 hour period was reported by Vera et al in 14 patients with sick sinus syndrome. There were seven men and seven women ranging in age from 44 to 85 years old (mean 66 years old). The corrected sinus node recovery time ranged from 240 to 2,065 msec (average 714 msec) before digoxin. The spontaneous sinus rates evaluated with Holter monitoring revealed an average of 56 beats per minute (range 43 to 69) before digitalis. For all patients with sick sinus syndrome in our study, the calculated average heart rate during 24 hours was 51.7 beats per minute. The average heart rate of patients with sick sinus syndrome was less in our study than in Vera's study, because patients with very severe forms of sinus dysfunction associated with prolonged sinus arrest or persistent severe sinus bradycardia were not included in Vera's study.

Total Heart Beats

It is sometimes difficult to diagnose the sick sinus syndrome by heart rate at single point in time, because the heart rate of patients with sick sinus syndrome is never constantly lower
than 50 beats per minute and it is influenced by variable factors such as exercise, emotion or stress. It is expected that the total heart beats per 24 hours would be useful for diagnosing Group I patients with the persistent sinus bradycardia of sick sinus syndrome, because the total heart beats (either 24 hours, or 6 hours during daytime or nighttime) would not be influenced by various temporary factors as compared with the heart rate at a single point in minute. The total heart beats per 24 hours or 6 hour interval was more useful than the rate at any one time in order to analyze the quantity of bradycardia. In our study, the total heart beats per 24 hours in patients with sick sinus syndrome was significantly lower than that in the control group. This suggests that the total heart beats per 24 hours is one of useful aid in the diagnosis of the sick sinus syndrome.

The total heart beats is influenced by daily activity and shows diurnal variation. However Tanigawa et al. have shown good reproducibility of total heart beats per 24 hours in a study with 18 patients with sick sinus syndrome. In this study, there was no significant correlation between the total heart beats per 24 hours and the maximal sinus node recovery time which has been reported as one parameter indicating the severity of the sick sinus syndrome. The sinus node recovery time could be related more to symptoms and signs of cerebral ischemia. On the other hand, the total heart beats per 24 hours may have some relationship to daily physiological and mental activity, because it gives a quantitative analysis of bradycardia.

Exercise Test

The exercise test is useful for a functional evaluation of sinus node activity. The physiological mechanisms involved in the response of the heart rate to exercise are complex, but for the most part are mediated through the autonomic nervous system because exercise increases the sympathetic and parasympathetic efferent stimuli to the heart. Agruss et al. reported that patients with sinus bradycardia due to vagotonia had cardiac outputs which were similar to those of age-matched control subjects, but that the stroke volume increased during exercise in the patients, while the heart rates increased during exercise in the control subjects. The patients with sick sinus syndrome in Holden's study reached the same level of maximal oxygen consumption as age-matched controls. However, Abbott et al. reported that patients with sinus node dysfunction were unable to achieve the same oxygen uptakes with maximal exercise as age and sex-matched control subjects.

In evaluating the response of the heart rate to an exercise test, Mandel et al. reported a normal response to exercise in 14 of 31 patients with sick sinus syndrome. Ferrer has reported that some patients with sick sinus syndrome may respond almost normally to the exercise stress test. In contrast, Abbott and Holden have reported that patients with sick sinus syndrome have a reduced rate of change in the heart rate as the level of exercise increases, compared with an age-matched control group.

It has been reported by several investigators that the maximum heart rate during exercise in patients with sick sinus syndrome is unable to match that of a control group at the same level of exercise. In this study, the patients with sick sinus syndrome showed a lower heart rate at each level of exercise when compared with our control group. However the increase in the heart rates from rest to the fourth stage of a modified Bruce protocol in the patients with sick sinus syndrome was similar to that of the control group.

With respect to the duration of exercise and the maximum heart rate achieved during the treadmill exercise test, there were no significant differences among the 3 groups of patients with sick sinus syndrome, which were divided by total heart beats per 24 hours. However there was a significant difference between Group A (49 years old or younger) and Group C (70 years old or older). It is conceivable that the duration of exercise and maximum heart rate achieved during the treadmill exercise test was in fact correlated with aging rather than the total heart beats.

CONCLUSION

Our conclusions were as follows. First, the total heart beats per 24 hours is one of the useful diagnostic criteria for sick sinus syndrome. Second, the total heart beats per 24 hours, independent of the maximal sinus node recovery time, is one of the parameters which can indicate the severity of sick sinus syndrome. Third, the duration of exercise and the maximum heart rate during the treadmill stress test (temporary exercise) are correlated with aging rather than with the total heart beats per 24 hours.
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