Effective use of table tennis for patients with chronic ischemic heart disease

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Abstract

This study examined the safe and effective use of table tennis for patients with ischemic heart disease, as well as considerations that should be observed when providing rehabilitation guidance. The study subjects were 15 heart disease patients (male, mean age 63.9 ± 5.8 years) who were in long-term rehabilitation. Three conditions of play were established for measurements, and heart rate, oxygen uptake, and rating of perceived exertion were recorded. The exercise intensity was in the target range (55.5 ± 10.6% heart rate reserve) when the patient and examiner played one-on-one, and this style of play was thought to be appropriate for patients with good physical strength and skill levels. Rating of perceived exertion was not related to physiological exercise intensity, including heart rate and oxygen uptake. When providing guidance, one must keep in mind the need to avoid competitive settings, check heart rate frequently, and adjust exercise intensity so as to stay within the target levels.


Key words: Ischemic heart disease, table tennis, heart rate, oxygen uptake

I. Introduction

Lifelong sports activities are considered to be beneficial for all people. It is also very important that people with ischemic heart disease (IHD) continue exercise as a rehabilitation or recreation activity (Schairer et al., 2003; Dobrosielski et al., 2002; Goto et al., 2003). Recently, studies on adapted physical activity or proposals to support exercise in people with internal disorders have included an increasing number whose subjects are IHD patients (Mocková, 2003; Lin, 2003). Kawahatsu et al. (1987) conducted a trial of cardiac rehabilitation by nonsupervised walking program, and they reported there was a significant reduction of exercise tolerance of patients. Given the significant physical and mental effects brought about by recreational sports or group exercise in people that desire an active lifestyle, the establishment of prescription criteria and guidance...
methods in particular are eagerly awaited (Shimomura et al., 2003).

Table tennis has been introduced in the rehabilitation programs of IHD patients, and is very useful as a recreational sport (Nohara et al., 1990). Target exercise intensity levels have been proposed (Brubaker et al., 2002). They indicate exercise prescription in coronary artery disease prevention, and rehabilitation programs with recommended exercise mode such as walking, stationary cycling, and stair climbing. Adapted recreational sports have a big impact on patients to motivate their long-term rehabilitation.

At the present, there are no detailed guidelines describing how table tennis should be implemented or what kind of guidance patients should be given.

In the present study, therefore, we measured exercise intensity in IHD patients who played table tennis under 3 different conditions, with the aim of identifying conditions under which table tennis can be implemented safely and effectively. We also investigated items to be observed when providing guidance about table tennis.

II. Methods

1) Subjects

The subjects were 15 patients with chronic ischemic heart disease, who had participated for a long time in our sports rehabilitation program and had good strength recovery. All subjects had old myocardial infarction, and 2 had undergone coronary artery bypass grafting. All subjects were males, and the mean age was 63.9 ± 5.8 years. Mean rehabilitation history was 58.9 ± 33.4 months, and height, weight, and body mass index for subjects are shown in Table 1. Prior to measurements, a treadmill test was carried out using Bruce’s protocol. Physical factors for each patient were measured at the endpoint of this test (Table 1).

Information about the study was provided to the patients, and they agreed to participate in the experiments. The patients who were treated with beta-blockers were not included in this study.

<table>
<thead>
<tr>
<th>Table 1. Profile of patients</th>
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<tbody>
<tr>
<td>Diagnosis (n)</td>
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<tr>
<td>OMI</td>
</tr>
<tr>
<td>CABG</td>
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<tr>
<td>Age (years)</td>
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<tr>
<td>Sex</td>
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<td>Height (cm)</td>
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<tr>
<td>Weight (kg)</td>
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<tr>
<td>Body mass index</td>
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<tr>
<td>Rehabilitation history (months)</td>
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</tbody>
</table>

End point of treadmill test (Bruce)

| Rest HR (bpm) | 60.3 ± 3.2 |
| Rest B.P. (mmHg) | 121.1 ± 18.5 |
| Endurance time (sec) | 524.1 ± 197.3 |
| Peak HR (bpm) | 134.3 ± 16.8 |
| Peak VO2 (ml·kg⁻¹·min⁻¹) | 27.1 ± 4.9 |

OMI: old myocardial infarction
CABG: coronary artery bypass grafting
B.P.: Blood pressure
Mean ± SD

2) Measurement protocol

Exercise was begun after confirming that there were no abnormalities in resting heart rate, electrocardiogram, or blood pressure. Subjects warmed up sufficiently and then took a 10-minute rest, after which they started to play table tennis. A physician specializing in rehabilitation medicine was always present during the sessions. When patients reached peak HR, table tennis was suspended if there were any abnormalities in electrocardiogram or subjective symptoms. The measurements were conducted at least 2 hours after meals. Measurements were conducted only one time per day. In order to avoid the possibility of cardiac accident, measurements were conducted in the afternoon (2–4PM) (Muller et al., 1987)
3) Experimental design

One-on-one table tennis play was selected for this study's measurements. We considered which types of sports activity were easier to do for heart disease patients, and in the end we established the 3 table tennis variations shown in Fig. 1. In the first condition (2 vs. 1), patients formed pairs and played against an investigator. Compared with play in which a single patient played against the investigator, the number of times each patient hit the ball was reduced by about half. The second condition was toss and stroke (T & S), in which an investigator tossed the ball from one end of the table and the patient hit it in return a single time. In this condition, there are no continuous hitting exchanges. In the third condition (1 vs 1), the patient and investigator hit the ball back and forth in general one-on-one play. All subjects played all 3 types in random order, and playing time was 20 minutes for each. These conditions were selected after consideration of previous studies and our own experiences of rehabilitation (Shimomura et al., 2001).

In all cases a competitive atmosphere was avoided, and the patient was instructed to return the ball naturally.

Factors were measured to estimate exercise intensity under each condition. Heart rate was recorded every 30 seconds by the telemetry electrocardiogram monitor system, and electrocardiograms were observed on a monitor. Oxygen consumption was measured during stroke with a Teem 100 (Aero Sport). A gas mask was attached to the patients' face with a Teem 100 on his back. These devices had a total weight of 3.3kg; however these devices were designed for measurement during sport, so no patients complained of discomfort during the test. Rating of perceived exertion (RPE) was measured at the end of stroke using the Borg scale. The Borg scale was shown to the patient immediately after the stroke, and patients pointed out their rating of perceived exertion. RPE was measured under the recommended instructions by the American College of Sports Medicine (ACSM) (Balady et al., 2000).

Heart rate reserve (HRR) was calculated for each patient from the maximum and resting heart rates obtained in the treadmill test. The proportion of HRR was obtained under each measurement condition. Metabolic equivalent units (METs) were obtained from peak VO₂ during the stroke, and resting VO₂ was measured prior to the stroke for each patient under each measurement condition. All measurements were conducted at the gymnasium for the usual rehabilitation program. The temperature of the gymnasium was 26.5 ± 4.2 °C.

Exercise tolerance test

The Bruce treadmill test was selected to evaluate the conditions of the patients because this protocol remains the most commonly used. Heart rate, blood pressure, electrocardiogram, RPE and VO₂ were measured before, during and after the exercise test. The test procedure included the indications for terminating exercise testing recommended by ACSM. Endurance time, HR max, VO₂ max, BP max and METs max were measured at the end point of the test.

Statistical analysis

All results are expressed as mean ± standard deviation (SD). Statistical differences among strokes were assessed by repeated measure

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Figure 1. Variations of table tennis stroke

O: staff
●: patient

1 vs 1
2 vs 1
toss and stroke*

* frequency: 30 times/min
analysis of variance methods and Fischer's PLSD test. A probability value of less than 0.05 was regarded as statistically significant.

III. Results

1) Peak heart rate during stroke

Peak heart rate (peak HR) obtained during the 2 vs. 1 type of play was 88.5 ± 14.9 bpm. With T & S, peak HR was 94.5 ± 18.8 bpm. Peak HR was highest in 1 vs. 1 play, at 101.1 ± 19.3 bpm (Table 2). There was a significant difference between each measurement condition (p<0.01).

<table>
<thead>
<tr>
<th></th>
<th>2 vs 1</th>
<th>T &amp; S</th>
<th>1 vs 1</th>
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</thead>
<tbody>
<tr>
<td>Peak HR (bpm)</td>
<td>88.5</td>
<td>94.5  **</td>
<td>101.1  **##</td>
</tr>
<tr>
<td>Peak VO₂ (ml·kg⁻¹·min⁻¹)</td>
<td>11.3</td>
<td>14.1 **</td>
<td>15.5 **##</td>
</tr>
<tr>
<td>RPE</td>
<td>10.8</td>
<td>10.1</td>
<td>11.0 ##</td>
</tr>
<tr>
<td>METs</td>
<td>2.9</td>
<td>4.0   **</td>
<td>4.4   ##</td>
</tr>
</tbody>
</table>

** : >2 vs 1(p<0.01)  
## : > T & S (p<0.05)

The proportion of HRR was obtained under each measurement condition is shown in Table 2. The numbers of patients who attained the level of target intensity recommended by ACSM was 10 (66.7%) in 2 vs 1, 12 (80.0%) in T & S, and 13 (86.7%) in 1 vs 1.

Typical heart rate curve is shown in figure 2. Heart rate was relatively stable within the target intensity recommended by ACSM.

The %HR reserve (%HRR) calculated from peak HR and HRR obtained from treadmill test are shown in and Figure 3.

2) Oxygen uptake during stroke

The maximum oxygen uptake value obtained in each of the conditions was taken to be the peak oxygen uptake (peak VO₂). This was lowest in the 2 vs 1 condition, at 11.3 ± 3.3 ml·kg⁻¹·min⁻¹. Peak VO₂ was 14.1 ± 4.2 ml·kg⁻¹·min⁻¹ in the T&S condition, and highest at 15.5 ± 4.2 ml·kg⁻¹·min⁻¹ in the 1 vs 1 condition.

Figure 4 show the values obtained under each of the measurement conditions in relation to maximum oxygen uptake from the treadmill test ( % VO₂ max ). The number of patients who attained the recommended level of target intensity was 11 (73.3%) in 2 vs 1, 12 (80.0%) in T & S, and 13 (86.7%) in 1 vs 1.

3) Rating of perceived exertion during stroke

RPE for each measurement condition is shown in Table 2. RPE was lowest in the T&S condition, at 10.1 ± 2.1. RPE was 10.8 ± 1.5 in the 2 vs 1 condition, and highest at 11.0 ± 1.4 in the 1 vs 1 condition.
4) METs during stroke

METs was lowest at 2.9 ± 1.0 in the 2 vs 1 condition, 4.0 ± 0.9 in the T&S condition, and highest at 4.4 ± 0.9 in the 1 vs 1 condition (Table 2).

IV. Discussion

In the present study, we ascertained whether or not chronic heart disease patients could play table tennis safely under 3 conditions. No severe abnormal findings that would necessitate the cessation of exercise were observed in any of the measurements. At present, it would seem reasonable to say that all the patients could play table tennis safely.

In the exercise programming proposed by the ACSM (Balady et al., 2000) for the type of patient in this study, an exercise intensity of 40–85% HRR is considered to be appropriate. The heart rate measurements in the present study revealed no dangerous instances in which this criterion was exceeded. Even the mean maximum value from the 1 vs 1 condition was 55.5% HRR, so that if competitive settings are avoided, table tennis would seem to be a safe recreational sport for chronic heart disease patients. In the 2 vs 1 condition the exercise intensity was 38.5% HRR, slightly lower than that recommended by the ACSM. Under this condition, therefore, it may be difficult for patients to maintain physical strength. A reasonable intensity of 46.6% HRR was obtained with T&S. Although this is within the appropriate intensity range, it is a relatively low level. Thus, T&S would seem to be appropriate for patients unfamiliar with table tennis or those with orthopedic problems. Of course, for those with good skill and physical strength, the 1 vs 1 style is preferable.

It has been reported that heart rate fluctuates

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**Figure 3.** %HRR calculated from peak HR and HR reserve obtained from treadmill test

**Figure 4.** %VO₂ max calculated from peak VO₂ and VO₂ reserve obtained from treadmill test.
when heart disease patients miss the ball while playing table tennis (Shimomura et al., 2001). Under the conditions established in the present study, it is desirable for the person playing table tennis to have a certain level of skill if the heart rate of the patient is to be stabilized. With beginners in particular, a certain level of technical guidance is needed to avoid stress, but in no case should the instructor emphasize a competitive mindset.

The parameters of %\text{VO}_2\text{ max} and %\text{HRR} are commonly viewed as being equivalent for establishing exercise intensity when exercise is prescribed (Brubaker et al., 2002). In the present results, however, the mean value of the %\text{HRR} indicated a comparatively lower level than %\text{VO}_2 \text{ max}. There is a possibility that differences of in calculative methods for each parameter influenced the result. This may have been caused by the complex influences of such factors as table tennis as a specific form of exercise, the medications the patients were taking. Such a result may not have been obtained if the subjects performed repetitive exercise with simple movements, such as walking or pedaling a bicycle. With group exercise in particular, there is an even greater necessity to establish and investigate physiological parameters.

The METs measured in this study were close to the standard of 4.1 (3-5) reported by the ACSM (Balady et al., 2000). However, the exercise intensity changed with the different conditions, so that exercise intensity should probably be indicated for more detailed conditions. It will also be necessary to further accumulate data.

When patients such as those in the present study exercise in a non-supervised setting, they must regulate the exercise intensity themselves. Generally, measurements of RPE can be a guide in maintaining appropriate exercise intensity. However, there are reports that prescribing exercise based on RPE can be difficult in some cases, depending on the type of exercise and the medications the patient is taking (Brubaker et al., 2002; Mocková, 2003). The results of measurements in the present study showed that nearly all patients had an RPE of 10 or 11, unrelated to the physiological exercise intensity. This may have been caused by the age or sensation of pleasure of the patients. Therefore, to maintain a suitable exercise intensity level and assure safety, frequent measurements of heart rate are needed.

In the present study, no abnormalities were found in symptom checks or electrocardiogram readings of patients during table tennis. Stauch et al. (1999) reported an exercise intensity of round of golf with participants including patients with IHD was at target level even on a hilly course. In the previous study, chest pain, premature ventricular contractions, Ischemic electrocardiogram changes and subjective symptoms were detected from patients with ischemic heart disease during skiing, swimming and aerobic dance (Kawahatsu et al., 1987; Shimomura et al., 1998,1999).

According to these results, the table tennis conducted in the present study, can be considered a relatively safe sport for patients with chronic heart disease.

V. Conclusion

Table tennis played under the 3 different conditions described herein is thought to be a safe recreational sport for chronic heart disease patients. More specifically, T&S is thought to be an effective method for beginners, and 1 vs 1 to be an effective method for players with a good level of physical strength and skill.

References


Table tennis for patients with coronary heart disease


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