ROLE OF REST INTERVAL DURING INTERVAL TRAINING AT OBLA SPEED

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ABSTRACT
The purpose of present study was to investigate physiological response at three different rest intervals during interval training at OBLA speed, and the relationship between a performance index and a recovery index. The performance index was expressed as the ratio of maximal velocity of 100m to 200m (Vmax100/Vmax200). The recovery index was defined as the ratio of blood lactate at different rest intervals (LArest3/LArest1). Thirteen well-trained swimmers performed interval training sets (16 X 100m, 8 X 200m) at three different rest intervals (rest1, rest2, rest3). Blood lactate at rest1 (LArest1) was significantly higher (p<0.05) than rest3 (LArest3) during 16 X 100m. However, there were no significant differences in blood lactate between the each rest interval during 8 X 200m. There was a tendency to underestimate blood lactate values when the rest interval become longer during 16 X 100m. It was shown that the subjects who had high values of Vmax100/Vmax200 were sprinters and those who had low values were distance swimmers. A significant positive correlation was found between Vmax100/Vmax200 and LArest3/LArest1. These results suggested that distance swimmers could recover faster than sprinters during rest intervals, and Vmax100/Vmax200 was a valuable index to assess the individual performance type and LArest3/LArest1 would be an indicator to evaluate the ability of recovery during interval sets.

Key words: interval training, rest interval, blood lactate, performance index, recovery index

INTRODUCTION
It has been suggested that improving endurance capacity allows swimmers to swim faster with less anaerobic metabolism so that lactate accumulation would be slower, and acidosis might be delayed [Maglischo 1993]. Endurance capacity corresponds to exercise intensity at blood lactate concentration of 4mmol/l [Kindermann 1979], and this intensity has been referred to as the onset of blood lactate accumulation (OBLA) [Sjodin 1981]. There has also been suggested that training intensity which approximates OBLA speed would improve endurance capacity without acidosis. Therefore OBLA would be the effective endurance training intensity [Yoshida 1982].

Various types of intermittent exercises (interval training) are commonly used in endurance training. Interval training consists of three factors (swimming velocity, rest
interval and repeat distance). Previous studies have reported about intermittent exercise during swimming training (Olbrecht 1985; Keskinen 1989; Troup 1992). These studies suggested that physiological intensity during interval training was influenced by swimming velocity, rest interval and repeat distance.

The purpose of the present study was to investigate physiological responses at different rest intervals during interval training at OBLA speed.

Swimmers can be generally classified into three performance types, which are sprinters, middle distance swimmers and distance swimmers. Those swimmers have their own different characteristics. Sprinters need to have higher level of muscle power and anaerobic capacity. In contrast distance swimmers should have higher aerobic capacity and middle distance swimmers need to have both aerobic and anaerobic capacities [Maglischo 1993].

Furthermore the purpose of present study was to investigate the relationship between these performance type (performance index) and the ability of recovery (recovery index) during different rest intervals.

METHODS

Subjects: The subjects were thirteen well-trained male college swimmers. The subjects were consisted of three sprinters, seven middle distance swimmers and three distance swimmers. Their physical characteristics are given in Table 1.

<table>
<thead>
<tr>
<th>Table 1 The physical characteristics of the subjects (n=13)</th>
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<tbody>
<tr>
<td>Mean Age (yrs)</td>
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<tr>
<td>19.8</td>
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<tr>
<td>SD</td>
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<td>Range</td>
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OBLA speed: To determine the OBLA speed, subjects swam 4 × 100m free style progressive-tests. Blood lactate accumulation was measured by finger tip method after each trial. The lactate determination was performed by YSI Model23L. OBLA speed was detected by interpolation from the swimming velocity versus blood lactate curve (Fig.1), according to the methods by Jacobs (1981).

<table>
<thead>
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<th>Table 2 Rest durations during interval training tests at present study</th>
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<tr>
<td>repeat distances</td>
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<tr>
<td>16×100m</td>
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<td>8×200m</td>
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</table>

Interval training tests: The subjects participated in six interval training tests of which the repeat distance were two types (16×100m, 8×200m) at three different rest intervals (see Table.2). The swimming speed during the tests was kept at OBLA speed.
**Fig. 1 Determination of the OBLA speed.**

**Performance index:** The performance index was obtained as the ratio of maximal velocity of 100m to 200m (Vmax100/Vmax200).

**Recovery index:** The recovery index was defined as the ratio of blood lactate at rest3 of rest1 (LArest3/LArest1).

**Statistics:** ANOVA was used to evaluate between different rest intervals. Regression analysis was used to analyze between Vmax100/Vmax200 and LArest3/LArest1. A probability level 5% (p<0.05) was selected for statistical significance.

**RESULTS**

The comparisons of blood lactate during 16×100m interval training sets using three different rest intervals were illustrated in Fig.2-a). The blood lactate at rest1 (LArest1; 2.7 ± 0.4mmol/l) was significantly higher (p<0.05) than rest3 (LArest3; 2.1 ± 0.3mmol/l). The comparisons of blood lactate during 8×200m interval training sets using three different rest intervals were shown in Fig.2-b). The blood lactate were 3.6 ± 0.8mmol/l, 3.5 ± 0.6mmol/l and 3.4 ± 0.6mmol/l at rest1 (LArest1), rest2 (LArest2) and rest3 (LArest3), respectively. There were no significant differences in blood lactate between the each rest interval during 8×200m.

The relationship between performance index and recovery index during rest intervals on 16×100m interval training sets were presented in Fig.3. It was shown that the subjects who have high values of Vmax100/Vmax200 were sprinters. On the contrary, those who have low values were distance swimmers. A significant positive correlation (p<0.01) was found between Vmax100/Vmax200 and LArest3/LArest1 during 16×100m interval training sets.
DISCUSSION
During 16 × 100m interval training sets, we found that the blood lactate at rest1 (LArest1; 2.7±0.4mmol/l) was significantly higher (p<0.05) than rest3 (LArest3; 2.1±0.3mmol/l). This result suggested that there was a tendency to underestimate blood lactate values when the rest interval become longer during 16 × 100m. Margaria et al.(1969) reported that while intermittent exercise the pool of creatine phosphate (CP) was restored during rest interval by the energy from the oxidative mechanism, then the energy which restored CP was utilized at the next exercise. According to a mathematical simulation model of energy output by Mader et al.(1982), the CP restored rapidly after exercise and most of restoration of CP occurred within 30seconds, then the rest of CP would be restored slowly. In other words, the restoration curve is likely logarithmic. This result suggested that when rest interval was longer, the energy contribution of CP would increase, then glycolysis energy
could be less so that lactate might accumulate at a slower rate. Consequently, in our study there were significant differences of blood lactate values between different rest intervals during 16×100m in spite of same swimming speed.

We found that there were no significant differences in blood lactate between the each rest interval during 8×200m. At 8×200m interval sets, the physiological intensity was not much different between 10 to 40 seconds rest intervals. In addition, the energy contribution of CP in total energy needed during 8×200m was less than 16×100m, because of the repeated distance was longer than 16×100m sets.

\[ Y = -243.671 + 293.409X \]

Fig. 3 Relationship between \( \text{Vmax100/Vmax200} \) and \( \text{LArest3/LArest1} \) during 16×100m interval training sets.

The subjects who had high values of Vmax100/Vmax200 were sprinters, on the contrary, those who had low values were distance swimmers at present results. Therefore the value of Vmax100/Vmax200 could be able to evaluate individual performance type.

A significant positive correlation (p<0.01) was found between Vmax100/Vmax200 and LArest3/LArest1 during 16×100m (see Fig.3). This result suggested that distance swimmers would have slower rate of lactate accumulation than sprinters. Jansson et al. (1990) reported that subjects with a high aerobic capacity have sufficient ability to restore the pool of CP, that is to say, the ability of restoration depends on the aerobic capacity. As distance swimmers generally have higher aerobic capacity than sprinters, they had lower values of LArest3/LArest1. At the present investigation, in conclusion, distance swimmers would recover faster than sprinters during rest interval between 5 to 20 seconds, Vmax100/Vmax200 was valuable index to assess the individual performance type and LArest3/LArest1 would also serve as a good indicator to evaluate the ability of recovery during interval sets.

REFERENCES