Effects of Intermittent Hypothermia and Hyperoxia on Blood Oxygen and Lactic Acid Accumulation

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Abstract

Purpose: To verify the positive effects of intermittent hypothermic applications on the removal of lactic acid and blood oxygen content; To verify the positive effects of intermittent hyperoxia on the removal of lactic acid and blood oxygen content; The effectiveness of the two applications was significantly different. Methods: The subjects of this study were 6 athletic trainees with an average age of 23 ± 2 years，height and weight of 172 ± 2.5 (cm) and 65 ± 3.2 (kg). Six subjects were challenged with a 2*2 * 300m-rowing as a stimulus, to observe the changes of lactic acid and blood oxygen content immediately and 8 minutes later after the exercise during intermission. Results: Interventional low-temperature Cooing (-120 ~ -140 ° C) measures, the blood lactic acid accumulation increased +1.2 mmol/l, blood oxygen content increased +4.1 mmHg, but blood lactate and blood oxygen content before and after the test did not show significant difference ($p > 0.05$). Interventional hyperoxia increased lactic acid accumulation by +0.8 mmol/l, showing no significant difference ($p > 0.05$), intermittent high oxygen concentration increased blood oxygen up +43.7 mmHg, a significant difference ($p < 0.05$). Conclusion: Intermittent hypothermic applications have a positive effect on blood oxygen and lactic acid removal; intermittent high oxygen application also has a positive effect on blood oxygen and lactic acid removal; Hyperoxia Recovery Applications Cooling recovery applications have a more positive effect on blood oxygen levels.

Key words: recovery application; metabolites; lactic acid removal

Introduction

For competitive athletes, Leeder et al. (2011) training or competition is their duties. Once, when overload, the body will feel temporary fatigue. To slow this situation, coaches and athletes focus on how to accelerate the recovery, to make sure athletes can get most quickly renewed. As indicated above, many recovery applications are rapidly developing. Many Studies have shown that Hyperoxia and Cooling have a positive impact on motor recovery.

Partial Body Cryotherapy is use by liquid nitrogen, subject who in the cold cabin steady (-120 ~ -140 ~ C) for 90s. Klimek et al. (2011) pointed out that low temperature applications can immediately prompted vasoconstriction and decreased muscle temperature, after vasodilation and increase the microvascular blood flow, accelerate the oxygen and nutrients into the muscles, and improve the metabolic rate of metabolic products, to achieve the rapid recovery effect.

Swenson Sw by RD, and, Karlsson (1996) and low temperature (Cooling) that local vasoconstriction reduces cell edema, which shortens the recovery time. Thorsson et al. (1985) hypothermia (Cooling) causes reflex vasoconstriction and is considered to contribute to the anti inflammatory effect of recovery. Bleakley et al. (2012); (Leeder et al. 2011) low temperature (Cooling) can slow muscle pain caused by strength and pressure after exercise, and accelerate muscle strength recovery.

Subjects should wear oxygen mask and take in 80% oxygen for 10 minutes. Plet et al. (1992) pointed out that inhale oxygen (80%) during post-exercise, were extracted and significant differences compared to normal air in elimination of lactate. Kaijser (1969) Inhale oxygen(80%) can increase blood gas exchange rate. Perry et al. (2005) Hyperoxia applications improve aerobic metabolism during training, increase training intensity, and accelerate recovery time. Haseler, Hogan, and Richardson (1999) after training. It has positive effect on increasing blood oxygen levels also decline heart rate, blood pressure and lactate.

In the past related studies, we can know the intervention of hyperoxia and cooling are both have positive impact on motor recovery. In this study, by comparing the differences between intermittent of low temperature and hyperoxia on blood oxygen and lactic acid, analysis of the differences in recovery, in order to provide better recovery applications in the future training.

Subjects

Undergraduates at the Graduate Institute of Athletics and Coaching Science from National Taiwan Sport university, Taiwan. The average age was 23 ± 2 years old, height and weight were 172 ± 2.5 (cm), 65 ± 3.2 (kg), as shown in table-1. After informing the subjects of the diagnostic content, subjects will sign the respondent’s consent letter.

Table-1： Subjects basic data

	Anthropometer
Age	23±2
High	172±2.5
Weigh	65±3.2
$Watt_{max}$	446±169
95 %$Watt_{max}$	376±150

Equipment

1) Diagnostic biosen c_ line, efk, lactate blood glucose analyzer
2) Alcohol, disinfection equipment, capillary tubes, surgical glove, lancet, destruction of red blood cells destruction agent
3) Space cryo-cabin, concept ii model d rowing machine, hyperoxia equipment, chronograph stopwatch

Experimental Design and Procedure

The experiment consisted of two parts:10-pad maximum power rowing test and acute HIIT exercise. The exercise is performed on an acute 2 * 2 * 300 m boating dynamometer with a single resting load (Rep) for 90 s, each set rest 10min. The intensity is the 95% of average of maximum individual paddle (10 pad). In each set of 2 * 2 * 300 m rowing, subjects will inhale oxygen (80%) and get into the cryo-cabin (-120 ~ -140 ° C) during recovery time, separately. The Concept2 indoor rowing machine as a training tool, resistance was set at level 5. Subjects were divided into 2 groups in a balanced order. Blood lactate concentrate and blood gas would be collected after the eight minutes of exercise.

The subjects carried out the 10 paddle maximum power rowing test on the first day, and calculated the maximum average of 10 paddle with an average of 95%. After that, subjects will get one day off. The third day and the next day, subjects were divided into two groups. They will do high concentrations of oxygen (80%) or get into the cryo-cabin, separated. In the fourth day, two groups will switch. After the two times exercise of 300m boating, blood oxygen gas and lactic concentration were collected immediately, and recorded 8 min biological parameters above. In the cryo-cabin group, after the biological parameters collected, subjects will go in cryo-cabin immediately and take twice 90 second treatment, each set with 3 minutes rest. In oxygen group, subjects will inhale oxygen (80%) for ten minutes. Data shown in table -2.

table-2: Blood collection time and blood volume

Intervention measures	The end training	8min
hypothermia	Blood volume10μl	Blood volume10μl
hyperoxia	Blood volume10μl	Blood volume10μl

Statistical Analysis

All biological parameters were performed using SPSS 20. Statistical Analysis were made using repeat samples t-tests. Data curve by Sigma Plot 8 Value of α =.05 was considered statistically significant.

Results

The subjects in the Cooing (-120 ~ -140 ° C) group, the blood lactic accumulation increased +1.2 mmol / l, blood oxygen increased +4.1 mmHg, but blood lactate and blood oxygen did not show significant differences ($p > 0.05$) compare pre-test. Interventional hyperoxia increased lactic accumulation by +0.8 mmol / l, showing no significant difference ($p > 0.05$), intermittent high oxygen concentration increased blood oxygen up to +43.7 mmHg, it shows significant difference ($p < 0.05$), specific data shown in Table-3.

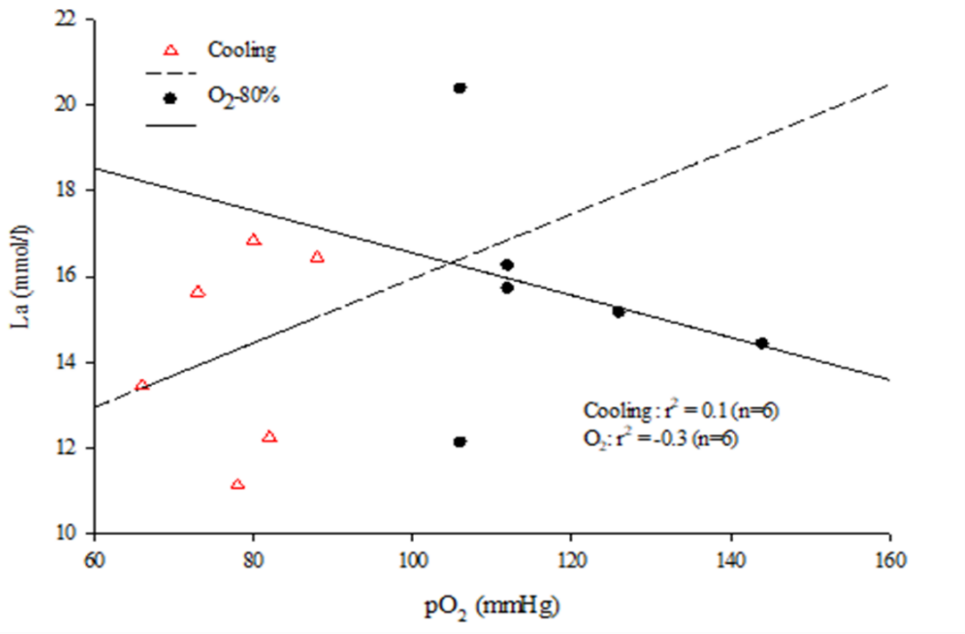
Table-3: Intermittent blood lactate accumulation and pO2 mean and standard deviation

Set	Cooling		O_2-80%	
	La(mmol/l)	pO_2 (mmHg)	La(mmol/l)	pO_2(mmHg)
Set-1	13.1±2.3	73.7±3.3	14.9±1.8	74.3±6.1
Interval-8 min	14.3±2.4	77.8±7.6	15.7±2.7	118±14.8
Diff.	+1.2	+4.1	+0.8	+43.7

Discussion

Urhausen, Heckmann, and Kindermann (1989) shows HIIT (300 m rowing) is dominated by anaerobic lactate fuction, the max lactate accumulation usually at 10 min.While intermittent period use cooing (-120 ~ -140 ° C), the blood lactic concentrations showed no significant difference. In this time, although the blood lactic accumulation increased + 1.2 mmol / l. However, there is no statistically significant differences between p pre-test and post-test. As indicated above, cooling effectively inhibited the rapid growth of lactic and accelerated the removal of blood lactic acid. While intermittent period of application of Cooling, the biological parameters of blood pO_2 and blood lactate had a positive correlation ($r2 = 0.1$), the oxygen content of the blood increase +4.1mmol/l, pre-test and post-test did not show significant difference. Illustrate the fact that the oxygen content of the blood after cooling has increased, but the increase speed did not inhibition of lactic production velocity, resulting in oxygen content in blood and accumulation of lactic produced positive correlation, but also pointed out that lactate removal ability has a direct relationship with the oxygen content in the blood. Klimek et al. (2011) express cooling stimulates vasoconstriction, after cooling the vasodilation improving microvascular blood flow, enabling oxygen and nutrients to enter muscle, accelerating muscle contraction, lactate and other metabolic products removal, and promoting rapid recovery of the body. In the second groups of exercise(O_2 80%), the accumulation of lactic was not significant, and the accumulation of lactic increased by +0.8 mmol/l. Therefore, it's come to the same conclusion above. Inhale oxygen(80%) in the intermittent period can inhibit the production of lactic, and expedite the elimination of lactic. The accumulation of pO_2 and lactic in oxygen(80%) showed a negative correlation ($R2 = -0.3$). As shown in Figure 1, lactic concentration has decreased in the case of increased blood oxygen content. It indicates that high concentration of oxygen can increase blood oxygen content and speed of oxygen in the blood, which effectively inhibits the speed of lactic production and accelerates the removal of lactic. Perry et al. (2005) high-concentration oxygen can improve the efficiency of aerobic metabolism, improve the training intensity, and speed up the recovery in training. Haseler, Hogan, and Richardson (1999) shows it also effected on after training period, increase of blood oxygen concentration, positive effect on reducing heart rate, blood pressure and lactic. Under high-concentration oxygen (80%), the blood oxygen content of subjects showed a significant difference, indicating that the high-concentration oxygen (80%) in the intermittent period played a positive role in the blood oxygen content, and increased the blood oxygen content of the whole body. Previous literature has reported that inhale of high-concentration oxygen (80%) can increase the rate of blood gas exchange (Kaijser, Lennart. 1969). The results of this study show that: the intermittent period intervene cooling and high-concentration oxygen (80%) both have positive impact on blood gas and lactic removal; compare with cooling, high-concentration oxygen (80%) has more positive impact on blood oxygen content.

Figure-1: Analysis of blood gas pO2 and blood lactic acid concentration



Conclusion:

Intermittent hypothermic applications have a positive effect on blood oxygen and lactic acid removal; intermittent high oxygen application also has a positive effect on blood oxygen and lactic acid removal; Hyperoxia Recovery Applications Cooling recovery applications have a more positive effect on blood oxygen levels.

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