

Effect of Rest Method on Fatigue Related Factors and Performance after Submaximal Exercise

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Abstract

The purpose of this study was to investigate the effects of rest method on fatigue related factors and performance after submaximal exercise. Twenty seven collegians participated in this study. All subjects performed an incremental treadmill running exercise, not to be able to perform exercise more on a treadmill. Each subject was relaxed for 10 minutes in the way of rest one of the relaxing 3 ways (sitting, lying, and jogging) after submaximal exercise, and it was made to the cycling movement again. The present study shows that fatigue related factors such as lactate, ammonia, glucose, and free radical were significantly decreased after active rest (jogging). On the other hand, the antioxidant capacity shows high level. There was no change of heart rate according to the rest type during the recovery period, 10 minutes. The heart rate, lactate, ammonia, and free radical show low level in the next exercise performance after the rest of activity. On the contrary to this the antioxidant and VO_2 max show high level. Also, motor performances such as VO_2 max and antioxidant capacity were significantly higher at active rest than passive rest. In conclusion, active rest is to show the fatigue substance lower than that of passive rest method, it was found that the performance capabilities of the next can be improved.

Keywords: Antioxidant, Active Rest, Free Radical, Lactate, Passive Rest

1. Introduction

Stress like exercise influences performance by causing various physiological, biochemical, and histological changes according to adaption of body energy metabolism. As such response to stress continues, it causes fatigue substance that is harmful to human body¹.

Fatigue exists along with appearance of mankind, is closely related to daily-life activities, and is defined as temporary malfunction phenomena due to overuse of our body. Factors of fatigue causing harmful effects on homeostasis are lactic acid, ammonia, lack of energy, glucose, hypoglycaemia, dehydration, perspiration, electrolyte imbalance. It is also reported that there is a high relevance to free radical and antioxidant substance^{2,4}.

Intense muscular activity can trigger oxidative stress, and free radicals may hence be generated by working skeletal muscle^{5,6}. Exercise training may increase production of free radicals and reactive oxygen species in different ways. The training type and intensity may influ-

ence free radicals production, which leads to differences in oxidative stress status between athletes^{7,8}. Oxidative stress is defined as an imbalance between production of free oxygen and nitrogen radicals (FR) and their reactive metabolites (RM) on the one hand, and on the other hand, by the ability of the organism to eliminate toxic action of these FR and their RM. This imbalance in favor of the RM leads to the oxidative modification of important biomolecules such as lipids, proteins and nucleic acids, resulting in the damage or change of the function of several organs or the whole organism^{9,10}. Antioxidants from biological point of view are substances that at low concentrations can prevent oxidation of important biomolecules and thus eliminate toxic effects of FR and RM by generation of non-toxic products^{11,12}.

The reduced oxidative stress may decrease muscle damage leading to early recovery from muscle soreness. Rapid recovery from the prior exercise is important for both beginners performing regular exercise to improve their health and athletes preparing for competition. Thus,

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antioxidant increase to attenuate exercise-induced muscle injury, inflammation, and pain may facilitate success in both health promotion and sport competition¹³.

In most of athletics, there is a situation where people do exercises repeatedly and continuously with a short recovery period. A prior sport game causes fatigue, which has a significant effect on performance and health in the next game^{14,15}. Optimum recovery methods are needed to maintain a high level of performance over the duration of a match, tournament or season. Therefore, ways to recover and remove factors related to fatigue embedded in human body after exercise should be concerned and be dealt with significantly. The objective of this study was to evaluate the potential of rest methods to minimize the fatigue induced by repeated matches.

2. Materials and Methods

2.1 Subjects

The subjects of this study is 27 male university students (age: 21.6± 2.5years, height: 171.68±13.3cm, weight: 66.42±3.41kg) who are good in shape and has no special disease through basic health checkup.

2.2 Methods

All subjects are allowed to do submaximal exercise up to all-out on a treadmill. After submaximal exercise, they take a rest with 3 different types, then, exercise by riding aerobikes. The types of rest consist of sitting, lying, and jogging lightly for 10 minutes. 27 subjects are applied to each ways of rest at four-day intervals, and the order of three ways is performed randomly. Variables (lactate, ammonia, glucose, free radical; d-ROMS, antioxidant; BAP, HRmax, VO₂max) of all subjects are tested and analyzed throughout four times (relaxed, after submaximal exercise, after a rest, right after exercise after a rest).

2.2.1 Free Radical & Antioxidant Capacity Test

The presence of free radical and antioxidant was tested with Free Radical Analytical System (FRAS4, Italy).

Free radical (d-ROMS; Reactive Oxygen Metabolites) Procedure:

1. Using a disposable sterile lancet prick the fingertip close to one side.
2. Once the capillary is placed in the microcuvette containing the R₂ reagent gently rock upside down.

3. Pour the contents into the R1 cuvette; be careful not to pour the capillary too.
4. Shake the cuvette overturning more times (10 seconds), be sure that the condensed chromogen is completely dissolved.
5. Place the cuvette in the centrifuge with one of the lined sides facing upwards.
6. Transfer the cuvette in the reading cell and wait for the result.

Antioxidant (BAP, Biological Antioxidant Potential) Procedure:

1. Using a disposable sterile lancet prick the fingertip close to one side.
2. The sample will be in the centrifuge for 90seconds in order to separate plasma from the corpuscular part (red cells).
3. Take a cuvette contain R₁ reagent and add a drop of R₂ reagent. Insert the cuvette in the reading cell.
4. Add 10ul of plasma in the same cuvette, close it with its cap, mixgently, and transfer the cuvette in the reading cell.

2.3 Statistics

Measured value of this study is calculated by mean and standard deviation using SPSS Ver 19.0. Repeated – measures ANOVA was used for 3(group) x 4(time) factor analysis. Scheffe *post hoc* test was used when a significant effect was observed. Significance level adopted was $p \leq 0.05$.

3. Results

Fatigue related factors such as lactate, ammonia and free radical show lower level in the active rest after submaximal exercise than in the passive rest ($p < 0.01$), also show lower level in aerobikes exercise after a 10 minute rest ($p < 0.01$). In addition, antioxidant shows higher level in the active rest after submaximal exercise than in the passive rest ($p < 0.01$), and so does in aerobike exercise after a 10 minute rest. Glucose concentration has no differences in all types of rest; after exercise, after a 10 minute rest, right after exercise after a rest. There is no difference in changes in heart rate during 10 minutes recovery period according to ways to rest after submaximal exercise. However, in the next exercise after a rest, an active rest from 1 minute to 6 minute shows lower level than a passive rest ($p < 0.05$),

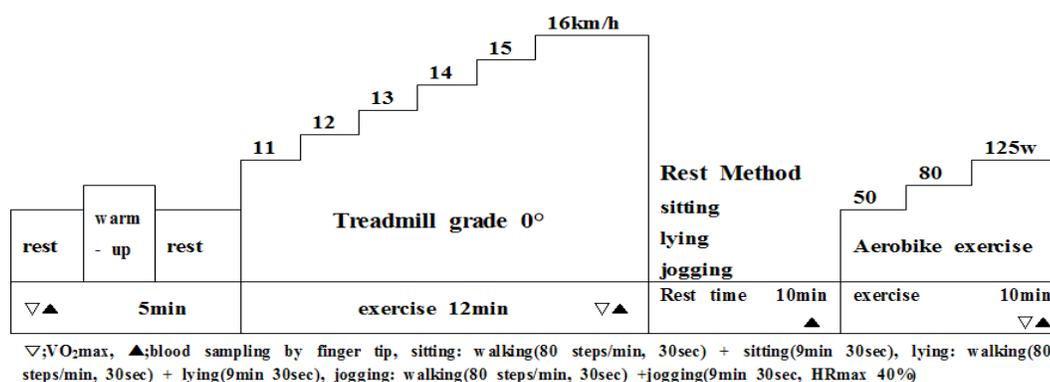


Figure 1. Exercise protocol.

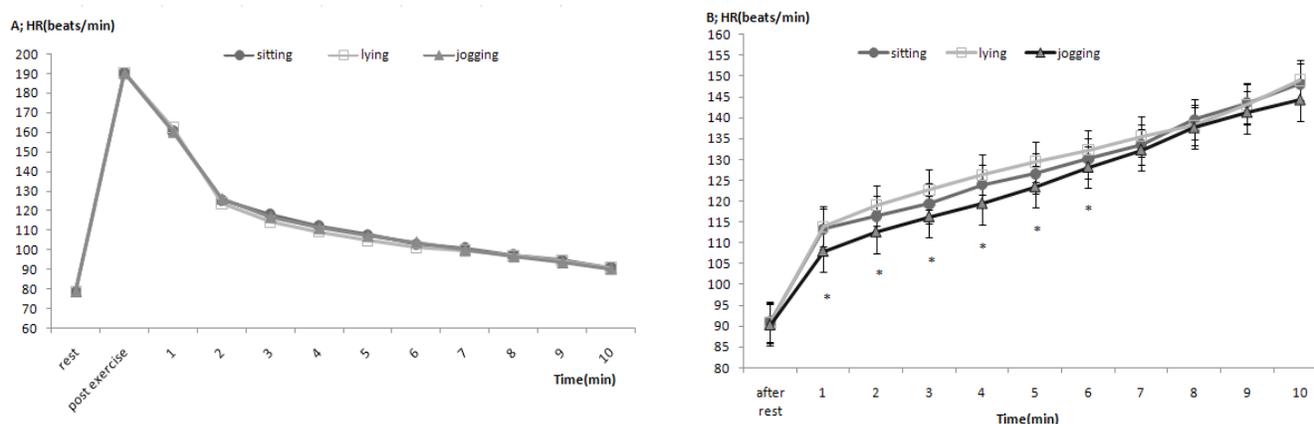


Figure 2. A: Change of heart rate during rest time after maximal exercise by treadmill. B: Change of heart rate during aerobike exercise after rest time.

Values are means ± SEM. * Significantly different from rest method (p<0.05).

also, in the next exercise after a rest, VO₂max show higher level in an active rest than a passive rest (p<0.01). There is significant correlation in the next exercise performance after the rest.

4. Discussion and Conclusion

The physical activity is possible in the human body in order that the cell can maintain life and make its function smooth as the blood ejected from the heart moves substances necessary for the organ system. The blood performs variety of functions like respiratory action, nutritive action, eliminative action, regulation action, protective action, and hormone transport, etc. In particular, it serves

an important function of transporting metabolites by the physical activity¹⁶⁻¹⁹.

Improvement of athletic performance can bring a positive result when physical, technical, physiological, psychological and strategic factors are worked together, and it is important to minimize fatigue causing factors. It can cause fatigues like the decrease of muscle contraction as it affects the metabolism of neural transmitter by increasing the use of oxygen according to the increase of energy source and oxygen uptake during exercise, the catecholamine, the lactic acid, and the ammonia^{1,20,21}. During competition, high-performance players are subject to repeated physical demands that affect their final performance. Measurement of lactate concentration in

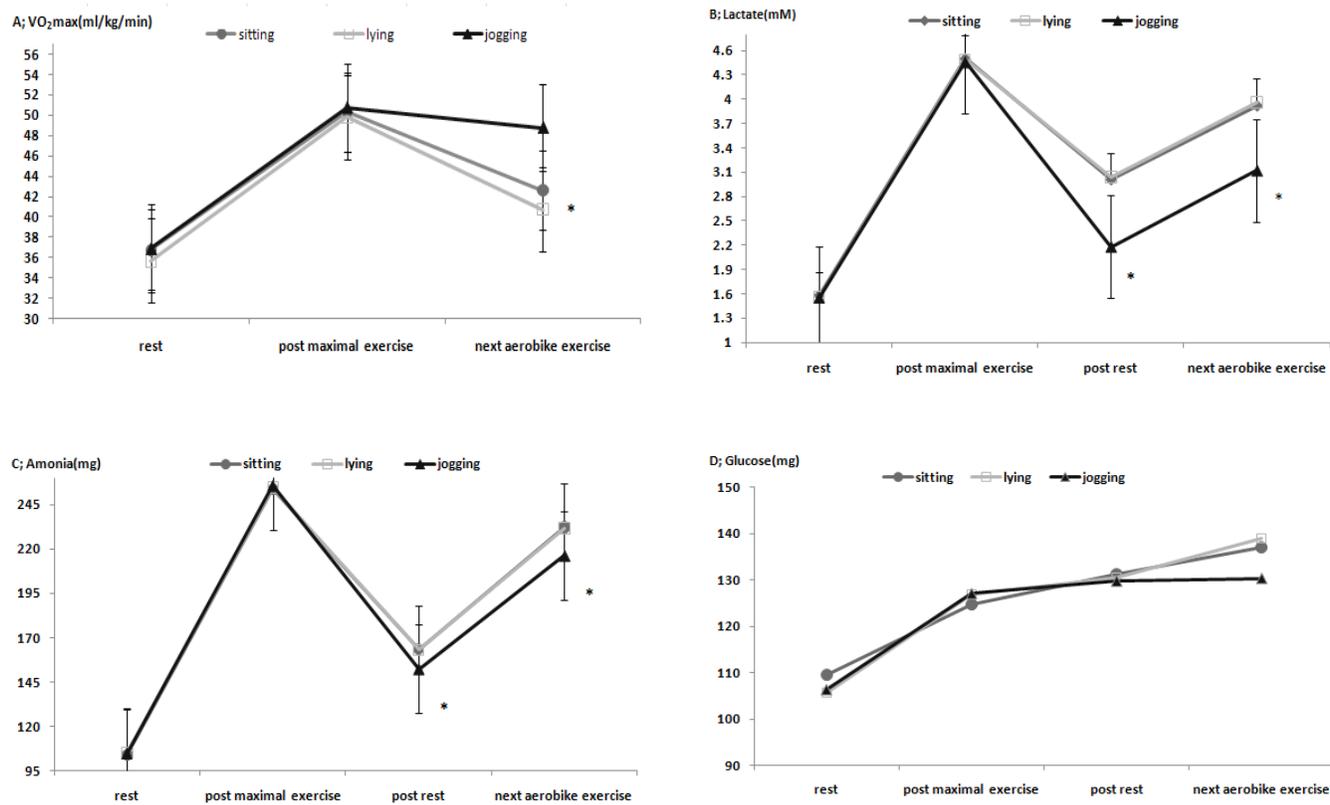


Figure 3. VO₂max(A), Lactate(B), Amonia(C), Glucose(D), Values are means \pm SEM.

* Significantly different from rest method ($p < 0.05$).

blood seeks to indirectly gauge physiologic responses to the increase in physical exercise. It requires fast elimination because the increase of fatigue related factors after exercise causes muscle damage as well as affects the muscle contraction velocity^{15,22,23}.

Athletes often perform exercise at high intensity, aiming to win a competition. At the start of an exercise program, muscle damage both in sedentary participants and athletes has often occurred²⁴⁻²⁶. Exercise-induced muscle damage is attributed to an exercise intensity-dependent increase in oxidative stress produced by mitochondrial process¹¹. Oxygen, although is highly required for living, can be toxic because it can be easily changed into oxygen free radicals (reactive oxygen species, ROS) and generates oxidative stress²⁷⁻³¹. Oxidative stress is a phenomenon associated with imbalance between production of free radicals and reactive metabolites and the antioxidant defence^{7,8}. It is well known that strenuous exercise training can induce an overproduction of reactive oxygen species with subsequent impairment of cellular macromolecules

and metabolism, leading to cellular dysfunction. In elite athletes, reactive oxygen species can add to other injurious factors for muscle tissue; therefore special precautions are required to avoid an increase in injury risk³². Also, during exercise, free radical increases because of increase in use of oxygen according to increase in hypoxia and infection due to damage of muscle. Such increases in free radical is related to insufficient recovery process, which facilitates accumulation of fatigue, lowers athletic performance and causes fatal damage³³⁻³⁵. When free radical continuously increases, it causes damage of DNA, protein and fat, which has negative effects on cellular tissue. Then, in the body, extraction of various enzymes and antioxidant that prevents free radical is facilitated to protect human body. Antioxidant capacity is the initial response that protects cells from effects of free radical, plays a role of preventing the production of new free radical, and the degree of vitalizing antioxidant can vary^{8,10,12,36}. Also, the antioxidant capacity is very important factor of resistance and recovery to the fatigue, and it would positively affect on

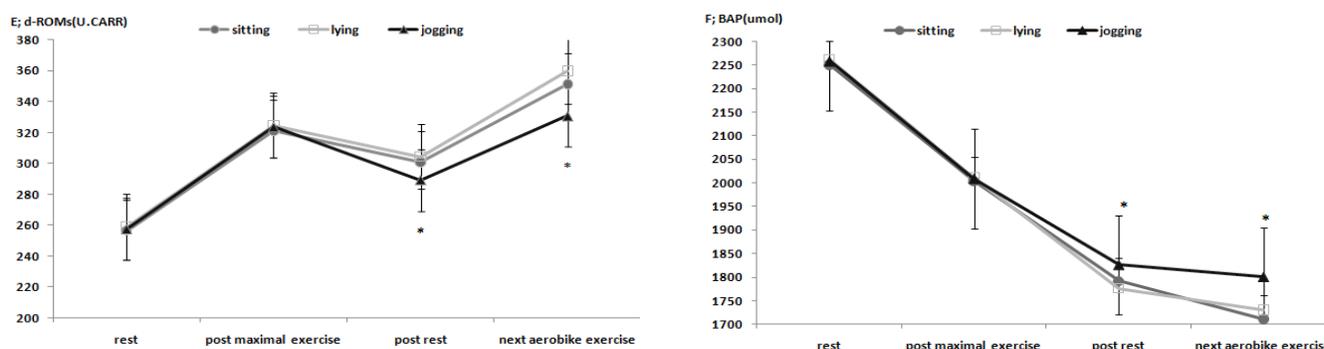


Figure 4. d-ROMs(E), BAP(F). Values are means \pm SEM.

* Significantly different from rest method ($p < 0.05$).

the next performance³⁷. It can cause problems of declining in result in a lot of sports games when the rest is insufficient between the exercises and between the games. Player has some matches a week during the sports games. In fact, there are instances where they take a rest only for a day or two. Furthermore, they should, all too often, continue to prepare for the next match after they take a rest for 15 or 30 minutes. Especially, we can often see that they play some matches a day in the tournament competitions. Also, most of team sports repeat games, giving it some limited break time in the middle of a game. For example, the games like handball and soccer, etc. are played, giving it short break time, 10 minutes at halftime. Accordingly, the fatigue built up can have a great effect on the performance in the second half of the match. Therefore, a way to recover fatigue effectively and quickly during sports is considered to be an important factor to determine performance. The advantage of active over passive recovery from long and intermediate duration exercise is well documented. Success has been attributed to metabolite washout and/or lactate (La) utilization by the active musculature. Recovery from muscle fatigue after exercise is known to have two beneficial effects: improved blood lactate elimination and a central nervous recuperation of the capacity for exercise³⁸. Hinzpeter et al. showed that active recovery exercises in swimming increase the clearance of blood lactate and therefore improve athletic performance within a single day of competition³⁹. Koizumi et al. showed that active recovery exercise would manage to increase the muscle oxygenation level, and improve the performance during the 2nd Exercise accompanied with blood lactate control⁴⁰. Spierer et al. showed that active

recovery at a work rate corresponding to 28% of VO_2 max increases total work achieved during repeated 30-second Wingate anaerobic power tests when compared with passive recovery in sedentary subjects and moderately trained hockey players⁴¹.

Like above the dynamic rest after exercise can remove the metabolic by-product fast by recovery muscle tension and improving the venous return velocity. As a result, the blood and circulation of lymph become better, and the body wastes can be removed fast as the nutrients increase to the organ system. Furthermore, it controls the increase of new active oxygen as the aerobic capacity is thoroughly improved. It can be useful to exercise performance capability and fatigue recovery by increasing the antioxidant enzyme activity in blood as the antioxidative defense system in the body is improved⁴².

In this study, active rest through light exercise rather than passive rest like relaxation after one-shot exercise has a positive effect on removal of fatigue related substance in blood and antioxidant. Furthermore, it is effective to heart rate increase related to the next performance right after submaximal exercise and maximal oxygen uptake.

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