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N F Romadhona[1*], G M Sari[2], D N Utomo[3]

[1]Department of Sport, Health Science, Airlangga University, Surabaya,
[2]Department of Sport, Health Science, Airlangga University, Surabaya,
[3]Department of Orthopedics and Traumatology, Dr. Soetomo Hospital, Surabaya,

[*]Corresponding author: romadhonadonna@gmail.com

Abstract. Recovery is an attempt to reduce blood lactic acid levels and make the body recover after physical exercise. The effect of cold water immersion (15°C) and sport massage combined with decreasing blood lactic acid level is still unknown. The subjects assigned to 3 groups, K1 group for recovery sport massage, K2 recovery group for combination of cold water immersion (15°C) with sport massage and K3 control group. Both groups performed sub-maximal physical exercise by doing a fast walk on the treadmill to reach (80% HRM) and then maintained for 5 minutes, followed by recovery process. ANOVA test of lactic acid level post treatment which shows there was a significant difference in the decrease of lactic acid level. The paired t-test of each group showed significant results in sports massage group (p = 0,001), combination cold water immersion (15°C) with sport massage group (p = 0,000) and a control group (p= 0,002). Recovery by soaking in contrasting waters, which result in alternating vasoconstriction and vasodilation, is considered to act in a manner similar to muscle pumping (vaso-pumping). Recovery by means of sport massage and combination of cold water immersion (15°C) with sport massage can decrease blood lactic acid levels.

1. Introduction

Sports activities have many benefits for the body including maintaining health, fitness and improving achievement in the field of sports itself. One type of sport that is common in the community is running. However, running, like other sports in general, can cause muscle fatigue. Fatigue will affect performance, especially in athletes. Rapid activation of glycolysis and increase in the concentration of hydrogen ions ($H^{+)}$ induces intramuscular acidosis which lead to decreased performance.

Fatigue is also influenced by the amount of Adenosine Tri Phosphate (ATP) energy and calcium [3]. During submaximal until high intensity physical exercise, the muscles contract in anaerobic conditions so that the formation of ATP occurs through anaerobic glycolysis. This results in an increase of blood and muscle lactic acid levels. Fatigue recovery is an important aspect of physical conditioning programs.

Recovery is a period of restoring the condition of the body to its pre-match state [9]. During the recovery phase, there will also be recovery of energy reserves, glycogen reserves, and myoglobin by oxygen filling, and also the removal of lactic acid from the blood and muscles [5]. Increased levels of lactic acid during strenuous exercise are caused by very high energy requirements which reach 100 times higher than during resting state. In anaerobic state, the results of metabolism are 2 ATP and the side product which is lactic acid [5].

Overcoming fatigue due to increased lactic acid can be achieved by cold water immersion (CWI) and sport massage methods. Previous studies showed that the CWI is more effective in restoring exercise with a temperature of 10° C - 15° C in a duration of 5 minutes - 10 minutes [10]. Whereas

Williams Brophy (2011) studied about the immediate effect and the slow effect of CWI after high intensity exercise for running performance, shows that soaking in cold water at 15° C for 15 minutes can reduce blood lactic acid levels.

Under cold temperature, the hypothalamus will regulate active vasoconstriction in the skeletal muscle. This will cause a person to shiver and increase the body temperature. At the same time, the adrenal glands secrete the adrenaline and noradrenaline hormones, while the thyroid gland secretes the thyroxine hormone, all of which aim to increase body temperature by increasing metabolism rate. Increased temperature in the body improve blood circulation so the demand of glucose and oxygen for muscle is met, which will help the recovery process of muscles [1].

Sport massage is a massage on certain parts by hand or special tools for blood circulation as a way of treatment or to relieve fatigue [8]. Sport massage is a massage technique that is often used by athletes before, during, and after a match or training. Because there is no consensus in recovery to reduce blood lactic acid levels yet, therefore research needs to be done to prove the effect of the combination of cold water immersion (temperature 15°C) with sports massage, and sport massage only.

2. Material and Methods

2.1 Type and design of research

The design of this research is an experimental laboratory with randomized pretest-posttest control group. This study aims to determine the comparison of recovery using sports massage and a combination of cold water immersion with sports massage to decrease blood lactic acid levels of Surabaya Indorunner community.

2.2. Research subject

This research was conducted at Atlas Sport Club Surabaya in May 2018. The population in this study was male runners aged 20-30 years who were members of the runner community (Indo Runner Surabaya). The sample size was 24 people who were randomly obtained and met the inclusion and exclusion criteria. Then, the samples were divided into 3 groups with 8 people each, where group 1 was given a sports massage as a recovery method while group 2 was given the combination of cold water immersion with sports massage as recovery method and group 3 is a control group.

3. Results and Discussion

The results of the descriptive pre-test analysis showed the mean value of lactic acid levels in group 1 (sport massage) was 3,63 with a standard deviation of 1.04. The post-test results of group 2 showed the average value of lactic acid 2,15 with a standard deviation of 0.79. Whereas in group 2 (combination of sports massage with cold water immersion) the pre-test value was 4.48 with a standard deviation of 1,12. The post test results obtained by group 2 showed an average value of lactic acid levels of 1.87 with a standard deviation of 0,41. Group 3 (control group) the pre-test value was 4,22 with a standard deviation of 0,55. The post test results obtained by group 3 showed an average value of lactic acid levels of 2,95 with a standard deviation of 0,41.

The average value of blood lactic acid levels in all groups measured in this research can be seen from table 1. The mean value of blood lactic acid levels 5 minutes after physical exercise (pre-test) in the recovery of sport massage group was 3.63 ± 1.0 mMol / L, while the combination group of cold water immersion 15°C with sports massage was 4.48 ± 1.12 mMol / L. The results prove that there is an increase in blood lactic acid levels as a result of anaerobic metabolism after the subject performed submaximal physical exercise by running on a treadmill to reach 80% of the maximum HR. The results of the normality test of each group, K1 = 0.789, and K2 = 0.447 was greater than 0.05 ($p > 0.05$), so that the data is normally distributed. High intensity physical exercise can increase lactic acid levels up to 15-25 mM when measured 3-8 minutes after exercise. These very high levels of lactic acid indicate the occurrence of ischemia and hypoxia [7].

From the results of table 3 the results of the effect test for lactic acid levels showed a P value <0.05 can be concluded, 1) recovery with cold water immersion of 15ºC can reduce blood lactic acid levels, 2) recovery with sports massage can reduce the blood lactic acid level. The value of blood lactic acid levels shows decrease in all groups in this research after the recovery phase (table 1). The blood lactic acid level of recovery phase in the sport massage group was 2.15 ± 0.79 mMol / l and in the combination of cold water immersion 15°C with sport massage group was 1.87 ± 0.41 mMol / l. This result shows that after being given a different form of recovery treatment, namely recovery sport

massage, or combination of cold water immersion 15°C with sport massage from the same submaximal physical exercise (80% maximum HR) and same duration of recovery time, a decrease was measured in value of blood lactic acid levels in each group. The results of the normality test for each group, K1 = 0.508 and K2 = 0.675, means the value is greater than 0.05 (p> 0.05), so the data are normally distributed. After physical exercise, the amount of blood lactic acid increases. Therefore, efforts are needed to accelerate the decomposition of lactic acid so that the body recovers quickly. The recovery phase is a condition that is needed by the body to return to the state before the exercise or match.

Table 1. Average and Standard Deviation Lactic Acid Result

Variable	K1 (8)	K2 (8)	K3 (8)
	Mean ± SD	Mean ± SD	Mean ± SD
Lactic Acid Level (*pre test)*	3.63 ± 1.04	4.48 ± 1.12	4.22 ± 0.55
Lactic Acid Level (*post test)*	2.15 ± 0.79	1.87 ± 0.41	2.95 ± 0.66
Lactic Acid Level (delta)	1.48 ± 0.75	2.61 ± 0.78	1.26 ± 0.45

The data are assumed normally distributed if the value of p> 0,05. Based on table 2 the results of the normality test showed that the variables of pre-test and delta lactic acid levels were normally distributed with a value of p> 0,05.

Table 2. Test the normality of the lactic acid

Variable	K1 (8)	K2 (8)	K4 (8)
	P value	P value	P value
Lactic Acid Level (*pretest)*	.789*	.447*	.968*
Lactic Acid Level (*post test)*	.508*	.675*	.003
Lactic Acid Level (delta)	.310*	.200*	.155*

Table 3. Paired T-test

		Mean ± SD	P value
Pair 1	PreK1_PostK1	1.48 ± 0.86	0.001
Pair 2	PreK2_PostK2	2.61 ± 0.85	0.000
Pair 3	PreK3_PostK3	1.26 ± 0.46	0.002

Based on the results of this study, the decrease in blood lactic acid levels in the combination of CWI with the sports massage group was more significant than sports massage group. Recovery of CWI combination with sport massage is the same as a recovery in contrast water (hot-cold) where there will be alternating phases of vasodilation and vasoconstriction. Recovery of CWI combinations with sports massage is better than sport massage because alternating vasoconstriction and vasodilation are thought to act in a manner comparable to muscle pumping (vaso-pumping), increasing blood flow and removing metabolites so as to improve recovery [4]. Increased circulation will increase the supply of oxygen which will help recycle lactic acid into an energy source.

4. Conclusion

Based on the results of the research and the results of data analysis that has been carried out, it can be concluded that recovery using massage can reduce blood lactic acid levels. Recovery of combination massage with CWI can reduce blood lactic acid levels and recovery of combination massage with CWI is better to reduce blood lactic acid levels than recovery massage after submaximal physical exercise.

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