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Effect of cold water immersion on blood lactate levels of table tennis players

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KEYWORDS

Recovery, Blood lactate, Water immersion, Fatigue

A B S T R A C T

The Cold water immersion (CWI) is a trendy recovery modality in fatigue reduction after doing intensive exercises. Fatigue occurs due to the lactate accumulation and causes prevention of muscle contraction. The aim of this study was to investigate the effect of different recovery methods on the blood lactate level. This semi-experimental study was assigned to 30 male table tennis athletes who were divided into three groups of 10 as follows: the passive recovery, active recovery and cold water immersion groups. The Bruce test protocol was assigned to all groups to measure the blood lactic acid in three stages. The results showed that the mean blood lactate during resting time and also immediately after the activity was not significant in all groups, but this amount was significant after doing different methods of recoveries between groups. Mean blood lactate reduction after recovery had the lowest amount in the passive recovery group (5/21±2/46)(mg/dl) ;while it had the highest rate in CWI group (1/8±6/21)(mg/dl). Our findings show that CWI have a significant effect on the reduction of blood lactate level ($p<0.05$). It can be concluded that active recovery has a better effect than passive mode in reducing the blood lactate levels in athletes but no significant differences were observed. Moreover, the CWI recovery method have a significant effect on the reduction of blood lactate rather than active and passive recoveries and are more effective methods for reducing the blood lactate levels after exercise.

Introduction

Fatigue is an event that always got to experience. When a person does exercise; this occurs more and quickly and the threshold increases in case of doing regular exercise .Some people define fatigue as decrease of muscle function [1]. Fatigue has an undesirable effect on continuing of exercise and reduces the quality of athletes' workout. There are lots of effective factors on a fatigue occurrence that the lactate increment is the most important ones. Increasing the blood lactate level is one of the most important factors that cause the

fatigue. After strenuous exercises, fatigue is created due to the changes in the muscle and then in the chemical factors of blood serum of the athletes. These changes are due to the waste products such as lactic acid. This substance is the product of anaerobic metabolism [2]. Lactate accumulation avoids the muscle contraction and causes fatigue. Reduction of fatigue due to the physical activity is a key success factor for professional athletes in competition or next exercise and hence the recovery time is an important factor in professional sport. Recovery from exercise training is an integral component of the overall training program and is essential for optimal performance and improvement. If the rate of recovery is improved, higher training volumes and intensities are possible without the detrimental effects of overtraining [3]. Understanding the physiological concept of recovery is essential for designing optimal training programs. Recovery has different methods that are done in various ways among the athletes and coaches. Recovery includes the factors such as: normalization of physiological functions (e.g., blood pressure, cardiac cycle), return to homeostasis (resting cell environment), restoration of energy stores (blood glucose and muscle glycogen), and replenishment of cellular energy enzymes (i.e., phosphofructokinase a key enzyme in carbohydrate metabolism) [4]. Other important physiological factors are return of respiratory system, circulation and body temperature to a state of pre-exercise [5].

Different recovery strategies are used by athletes during competition and training to enhance the recovery [6]. Throughout history immersion in cold water has been used as a therapeutic treatment for restoring physical and mental health, but nowadays it is used as a recovery strategy [7]; and become popular recovery modalities that recently were lionized by athletes and coaches [8]. Water immersion is similar to the mechanisms attributed to active recovery without any extra energy cost involved. Also the heat dissipation capacity of water is considerably greater than that of air, as the ratio of the heat conductivity of water to the air is approximately 24:1. So it can enable the body to recover faster and also the body would be able to replenish energy reservoirs, more effectively [9].

Some researchers have shown that water immersion maintained the performance and reduced fatigue consequently [10]. In another study, reported that the Mean blood lactate reduction after recovery in the cold water immersion and contrast water immersion were higher than hot water immersion, in the female sprint swimmers[11]. In another study, observed no water immersion effect, independent of the water temperature, on the lactate levels following recovery [12]. In another study reported the cold water immersion and contrast water immersion, maintained performance and improved recovery from high-intensity cycling compared to active recovery [13]. In another study, it was shown that there are no effects on the blood lactate levels between passive and active recovery after intensive activity [14]. All studies employed some form of cold water immersion (CWI) intervention after exercise. The most popular water immersion temperature was between 10°C and 15°C [10]. Due to the lack of research on water immersion and the fact that the table tennis is a reaction/speed game that requires explosive anaerobic movements; different results are obtained in this research in comparison with the previous researches; this study sheds the light on investigating the effect of the cold water immersion on the blood lactate level of table tennis athletes in

comparison with active and passive recoveries.

Methods

Subjects

This semi-experimental study was carried out on 30 male table tennis athletes, age (20.2±3.4 year), height (173.6±4.8 cm), weight (67.4±9.2 kg) and BMI(22.2±2.5) who were divided into three groups of 10. We finally employed 30 healthy males who volunteered for the study after providing written informed consent. Participants were all familiar with exercise testing. All participants enrolled in the Bruce test protocol; then each group started its own recovery for 15 minutes.

Selecting Water Temperature for Recovery

The most popular cold water immersion temperature was between 10°C and 15°C. [10]. But in this study we selected 12°C for cold water immersion recovery. The participants of cold water immersion were immersed in the water up to Manubrium Sterni.

Type of exercise

The Bruce test protocol was used to increase the level of blood lactate in subjects. This test includes 7 phases. This test is done on the treadmill and started with low intensity; every 3 minutes. The speed and the gradient (slope) of the device increased up to the level in which the subject could not perform the test anymore and became totally exhausted

Test groups

After the Bruce test protocol done, the subjects were divided into 3 groups of 10: first group is the passive recovery that after the activity they sat on a chair. The second group is active recovery that after activity they run slowly with 40 to 60 % of Vo2max. Third group is Cold Water Immersion (CWI) that immersed athletes in the cold water of 12° immediately after the activity.

Lactic acid measurement

The lactic acid level was measured for all subjects in 3 phases of before the test, immediately after the test and immediately after the recovery.
The sitting position is considered for the Blood sampling of all subjects and the measurement was done by brachial artery blood sampling (7ml) for each subject. In this study the English Rondox kit is used.

Statistical analysis

All experimental and calculated values are presented as a mean +/- standard deviation. The repeated measures analysis of variance test is utilized to investigate the changes of variable means. The Bonferroni post Hoc test is applied for the significant variation. The mean differences level between 2 groups of independent T-Test and the mean difference level of pretest and dependent statistical T-Test are always investigated. The significance level was set at $p<0.05$. All data were analyzed using the SPSS version 17.0.

Results and Discussion

Thirty healthy male young high-level table tennis players were recruited who met the inclusion criteria and they were divided into three groups of 10: Passive recovery group, Active recovery group and Cold Water Immersion recovery group. All participants aged between 16 to 26 years old. Their average age was 20.2 year (±3.4) years old,

and their body weight was a mean of 67.4 kg (±9.2) and body height was 173.6 cm (±4.8 cm) and BMI was 22.2 kg/m2 (±2.5). (Table 1). The resting blood lactate (mg/dl), Lactate after the Bruce test protocol (mg/dl), and Lactate after the recovery (mg/dl) of the subjects (Divided for each group) are illustrated in Table 2. (Table 2). Lactate level variations after passive recovery, active recovery and cold water immersion are presented in Figures 1, 2 and 3 respectively. Figure1. Showed that immediately after activity and applying the Bruce test protocol, the blood lactate levels significantly increased compared to the rest position, and after the passive recovery, the blood lactate levels significantly reduced compared to the after the Bruce test protocol. (Figure 1). Figure2. Showed that immediately after activity and applying the Bruce test protocol, the blood lactate levels significantly increased compared to the rest position, and after the active recovery, the blood lactate levels significantly reduced compared to the after the Bruce test protocol. (Figure 2). The significant increase in the blood lactate levels immediately after activity and applying the Bruce test protocol compared to the rest position is showed in Figure 3; meanwhile, the blood lactate levels significantly reduced after the Cold Water Immersion (CWI) recovery compared to the after the Bruce test protocol. (Figure 3). According to the results, all recovery groups have considerable lactate removal effect after the exercise. The Cold water Immersion (CWI) group has a significant effect to reduce lactate levels than active and passive recoveries ($p<0.05$). Although no Significant differences between active and passive recoveries were observed to reduce the lactate levels. (Figure 4)

The result of three effective recovery programs in removing the accumulated lactate acid in the blood of athletes showed that the water immersion significantly removes lactate compared with other methods of recovery. Also results demonstrated that there was no significant difference between active and passive recoveries. Our results showed that immediately after activity and applying the Bruce test protocol, the blood lactate levels increased, due to the secretion of lactic acid produced by the muscle into the blood. Rate of lactate removal depends on factors such as lactate production amount during activity periods and the type of recovery in used. During passive recovery (complete rest), half-life of lactate is between 15 to 25 minutes and after approximately 30 to 60 minutes of activity finished, the blood lactate level reaches to the rest position [15]. The time in which the entered lactate to the body decreases in the blood serum or plasma is called as half-life of lactate [16].

Adequate amount of Oxygen is available during the recovery period that associates with decrements in intensity of the exercise. The connected hydrogen's to the lactate acid are taken and consequently oxidized. As a result lactate acid converts to the pyruvic acid easily and reused as a new source of energy [17]. Our results showed that after the passive recovery, blood lactate level is reduced, but this reduction in the passive recovery group was lower than other groups. Most reduction in lactate acid was observed in the results obtained from active recovery rather than the one from the passive one. The reason of more reduction of blood lactate levels in case of active recovery than the passive one is not clear. But as mentioned before, the half-life of lactate is about 15 to 25 minutes after exercise and active recovery can reduce this time more and potentially causing more decrease of blood lactate level and deliver it to the normal resting level after active recovery. There is too much benefit of active recovery

and some of the factors are: maintenance and protection of white blood cells that helps the immune system effectively prevent of enzymes deactivation, minimizing the harms due to accumulation of acid lactic in the body and more other benefits that shows why the clearance of lactate is on benefits [18]. Results showed a little bit more reduction in the blood lactate level after active recovery than passive ones while no significant reduction were resulted compare to the cold water immersion.

The Primary concept behind the cold water immersion is in reducing the painful feeling that depends on Delayed onset muscle soreness (DOMS) that occurs with damage of muscle fibers and causes to decrease of muscle pain and increases the speed of recovery time [10,19]. This kind of recovery causes the contraction of blood vessels, depletion of waste product such as lactate acid to the tissues that are not involved in pain, reduces the metabolic activity and delaying of physiological processes, reduces the inflation and finally reduces the tissues' disability that these items are of benefits of cold water immersion. Cold water immersion may cause a reduction in pain through several possible mechanisms, namely the inhibition of nociceptors, reduction in metabolic enzyme activity, reduction in muscle spasms or an altered nerve conduction velocity [20,21]. Moreover, Cold water immersion leads to the reduction of heart rate compare to the warm water immersion. Our results showed that the cold water immersion causes the significant reduction in the blood lactate level of athletes [22]. Compared with the active recovery and passive recovery, cold-water immersion significantly lowered temperature after the recovery phase [23]. Exposure to a cold-water immersion intervention can rapidly decrease muscle temperature and muscular force output [24]. Water immersion methods cause's athletes to feel more relaxed and this issue can happen due to the floating force that is oppose of gravity and supports the part of body weight that is floating in water. This force causes lightness and weightlessness feeling. Also during water immersion neuromuscular responses reduce. As a result general comfort and a reduction in fatigue would be felt after exercise. Various methods of water immersion cause the complete comfort in muscles and a reduction in tension and anxiety [8,25].

Table.I

Groups	Age)Year(	Height)cm(	Weight)kg(	BMI)kg/m^2(
Passive recovery	4.05 ± 21.3	4.7 ± 175.1	8.8 ± 67.2	2.9 ± 21.8
Active recovery	4 ± 20.6	5.2 ± 172.7	10.1 ± 62.3	2.6 ± 23.2
Cold Water Immersion	2.7 ± 19.5	4.4 ± 173.7	9.6 ± 69.1	2.3 ± 22.7

Table.2 Represents the Measuring lactate level variations during different stages of each group

Groups	Lactate Rest position (mg/dl)	Lactate After Bruce Test (mg/dl)	Lactate After recovery mg/dl
Passive recovery	2.02 ± 7.9	18.6 ± 66.9	21.5 ± 46.2
Active recovery	2.01 ± 7.6	12.7 ± 71.3	14.09 ± 46.9
Cold Water Immersion	2.7 ± 7.2	14.7 ± 64.3	8.1 ± 21.6

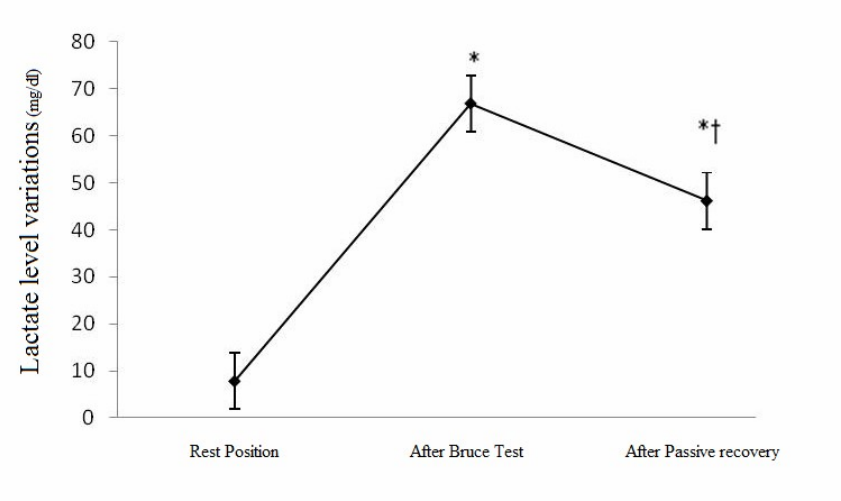

Fig.1 Lactate level variations after passive recovery

*Significant difference compared to the first stage of measurement.
†Significant difference compared to the second stage of measurement.

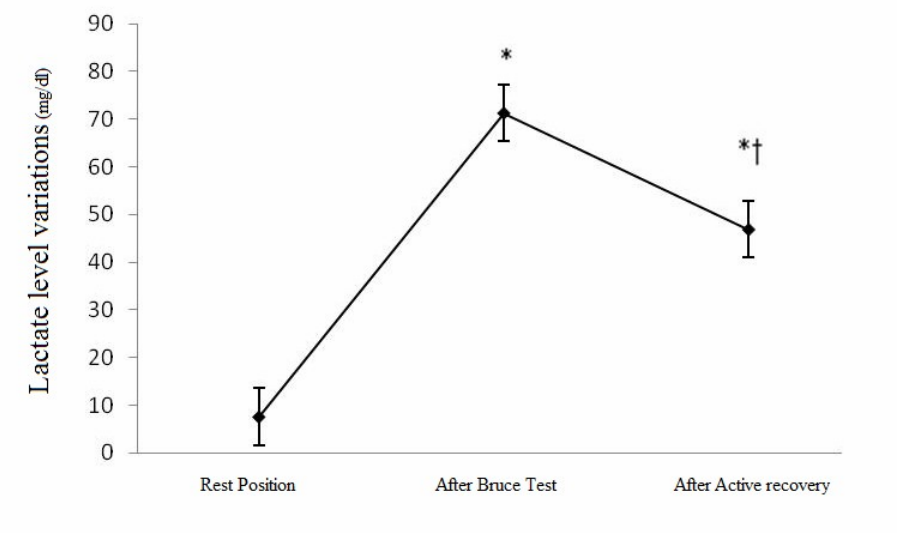

Fig.2 Lactate level variations after Active recovery

*Significant difference compared to the first stage of measurement.
† Significant difference compared to the second stage of measurement.

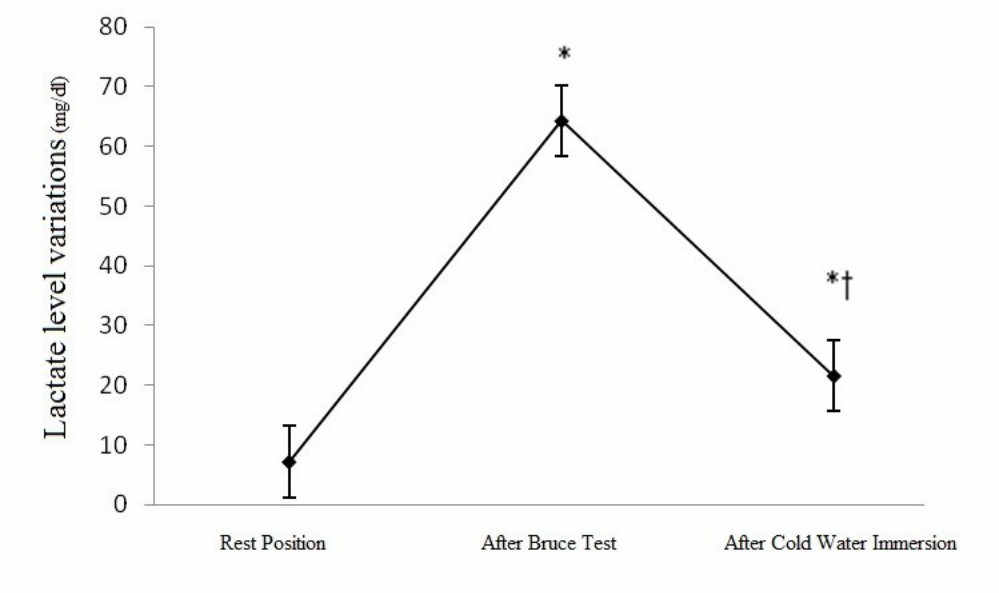

Fig.3 Lactate level variations after Cold Water Immersion recovery
*Significant difference compared to the first stage of measurement.
† Significant difference compared to the second stage of measurement

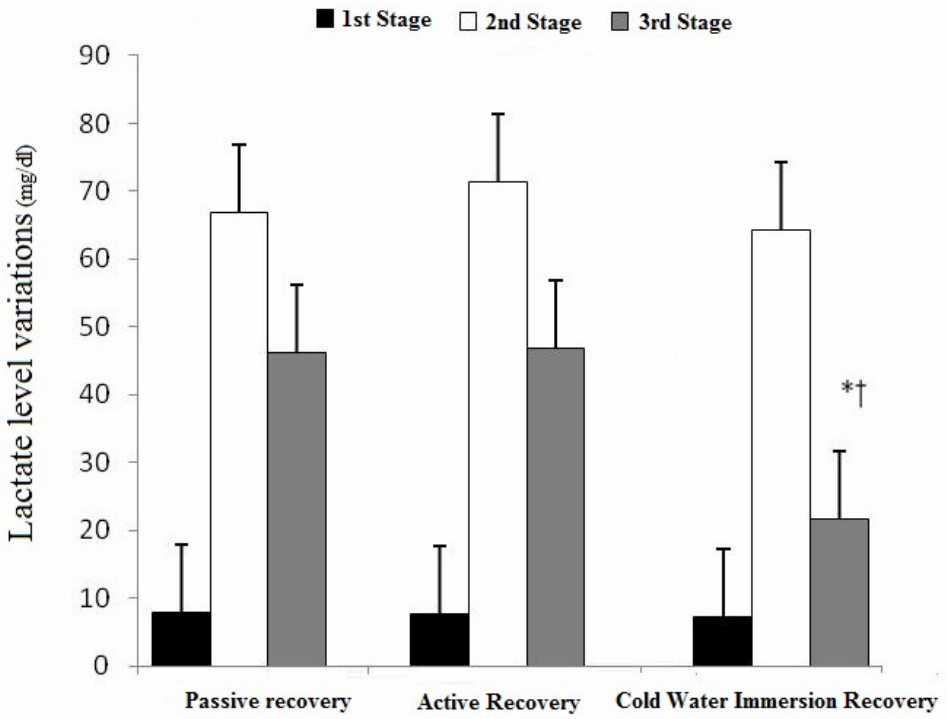

Fig.4 Lactate level variations between difference recovery
*Significant difference compared to the passive recovery
† Significant difference compared to the active recovery

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