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Comparison of contrast water immersion, active recovery and passive recovery on blood lactate and CRP levels in table tennis players

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Abstract

Introduction: The benefits of rapid recovery after intense exercise are widely recognized, and lactate elimination and inflammation reducing are the main indicators of recovery rate. The effects of water immersion on lactate elimination and C-reactive protein (CRP) not well known, thus the purpose of this study was to investigate the comparison of contrast water immersion, active recovery and passive recovery on blood lactate and CRP levels in table tennis players.

Material & Methods: 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 contrast water immersion (alternating hot (38^{o}C) and cold (12^{o}C)) groups. All of the subjects undertook the Bruce test protocol and blood lactate and CRP levels were measured before and immediately after the intense exercise and after 15 min of recovery.

Results: Repeated measures ANOVA test showed that the blood lactate and CRP levels increased immediately after the intense exercise in all three groups ($P<0.05$). Blood lactate and CRP levels decreased after 15 min passive recovery, active recovery and contrast water immersion compare to after the intense exercise ($P<0.05$). Bonferroni Post hoc test indicates that blood lactate levels were lower after the contrast water immersion than the passive recovery and active recovery ($P<0.05$); however for CRP, no significant differences were observed between three types of recovery.

Conclusions: It can be concluded that contrast water immersion is better than passive and active recovery for blood lactate elimination in table tennis players after intensive exercise; however all of these strategies are well for CRP reducing after intensive exercise.

Key words: Recovery, Blood lactate, Water immersion, Fatigue, Inflammation

1. Introduction

Recovery from exercise involves the return of body from a fatigued state towards its normal physiological and performance baseline. Quicker recovery from fatigue has potential benefits in that it allows athletes to retain or compete at higher intensity and could provide a competitive edge (1). C-reactive protein (CRP) is a commonly used marker of systemic inflammation (2) that has also been used to investigate the level of inflammation post-exercise (3). A large amount of therapeutic modalities are used after sports activities to improve skeletal muscle recovery, the most commonly used modalities are: active recovery (4,5), cryotherapy (6), massage (7), contrast heat therapy (use of hot and cold water immersion) (8,9), hydrotherapy (10), stretching (11), and electric stimulation (12). However, the scientific evidence behind these modalities is limited.

Passive recovery refers to an athlete performing nothing out of the ordinary after strenuous activity (13) and it is generally used as the control in recovery research, since no attempt is made at influencing the physiological responses of the body.

In terms of active recovery, light to moderate exercise has been generally accepted as a method to enhance recovery after strenuous physical performance (14). It has been postulated that active recovery increases the ability to metabolize muscle lactate and maintain power outputs and has a beneficial effects on psychological recovery by enhancing relaxation (15). Active recovery is thought to result in an increased blood flow through the muscle, which may improve nutrient delivery and waste metabolism. Removal of exercise-induced waste may be linked to intra- and extravascular fluid shifts as they have been observed to closely follow blood lactate kinetics (16).

Another method of recovery that is gaining popularity is water immersion. In this method, the pressure of water on the body causes a redistribution of body fluid with increasing levels of immersion increasing the hydrostatic pressure on the body (17). Fluid shifts due to immersion appear to increase cardiac output and muscle blood flow, and reduce peripheral resistance increasing blood lactate recovery without a subject expending the energy required during active recovery (18).

Due to the lack of research on the effects of water immersion on blood lactate and CRP levels and the fact that the table tennis is a reaction/speed game that requires explosive anaerobic movements; the present study was done to comparison of contrast water immersion, active recovery and passive recovery on blood lactate and CRP levels in table tennis players.

2. Materials and methods

Subjects

This semi-experimental study was carried out on 30 male table tennis athletes aged 16-27 years who were divided into three groups: the passive recovery (n=10), active recovery (n=10) and contrast water immersion (n=10). The Islamic Azad University, Marvdasht branch Ethics Committee approved the study and written informed consent was obtained from all subjects.

Intensive 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.

Passive recovery

The subjects in the passive recovery group were performed nothing out of the ordinary after the intensive exercise for 15 min.

Active Recovery

The subjects in the active recovery group were run with 40-60 % of their hear rate reserve (HRR) for 15 min.

Contrast Water Immersion

The subjects in the contrast water immersion were immersed up to the level of Manubrium Sterni alternating in hot water (38^{o}C) for 3 min and cold water (12^{o}C) for 2 min and vice versa. This protocol was repeated 3 times.

Biochemical measurement

Blood samples were collected in 3 times: before and immediately after the intense exercise and after 15 min of recovery. Plasma lactate levels were determined in duplicate via a spectrophotometric enzymatic lactate Kit. CRP levels were determined in duplicate via an enzyme-linked immunosorbent assay (ELISA) kits (Diagnostics Biochem Canada, Inc). The intra and inter-assay coefficients of variation for hs-CRP were $<$5.7% and a sensitivity of 10 ng/ml.

Statistical analysis:

Data were analyzed using SPSS software for windows (version 17, SPSS, Inc., Chicago, IL). 3×3 repeated measures ANOVA was used to evaluate time-course change in variables. Post hoc analyses (Bonferroni) were then performed when warranted. The significance level of this study was set at $P<0.05$.

3. Results

Personal characteristics of the subjects in each group are presented in the Table 1. All participants aged between 16 to 27 years old.

Table 1. Personal characteristics of the subjects in each group

Groups	Age (year)	Height (cm)	Weight (kg)	BMI (kg/m^2)
Passive recovery	21.3 ± 4.0	175.1 ± 4.7	67.2 ± 8.8	21.8 ± 2.9
Active recovery	20.6 ± 4.0	172.7 ± 5.2	62.3 ± 10.1	23.2 ± 2.6
Contrast water immersion	20.6 ± 3.6	174.5 ± 5.2	67.2 ± 9.7	21.9 ± 2.2

The changes of blood lactate levels in the passive recovery group, active recovery group and contrast water immersion group are illustrated in Figure 1. Repeated measures ANOVA test showed that the blood lactate levels increased immediately after the intense exercise in all three groups ($P<0.05$). Blood lactate levels decreased after 15 min passive recovery, active recovery and contrast water immersion compare to after the intense exercise ($P<0.05$); however, Bonferroni Post hoc test indicates that blood lactate levels were lower after the contrast water immersion than the passive recovery and active recovery ($P<0.05$). No significant differences were observed between the passive recovery and the active recovery.

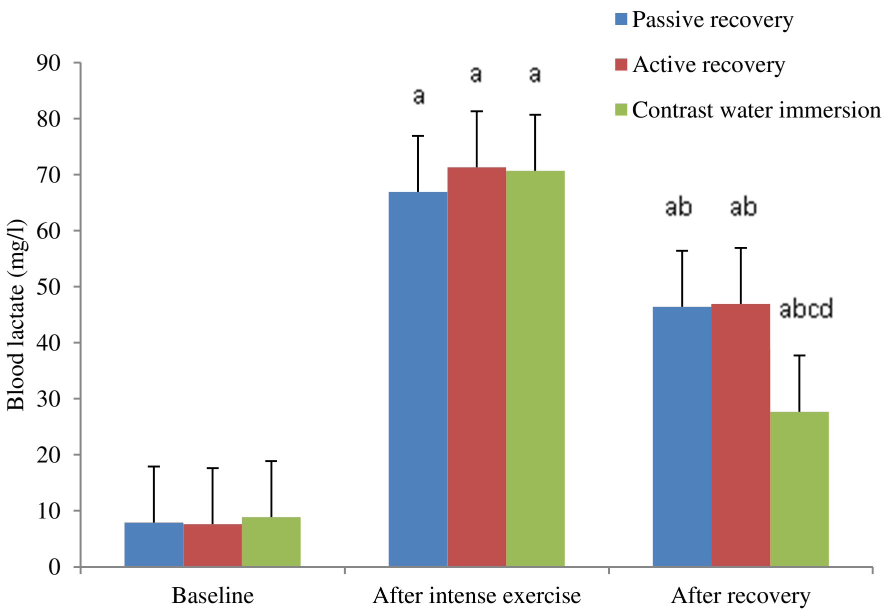

Figure 1. Changes of blood lactate levels after passive recovery group, active recovery and contrast water immersion

a. Significant difference with baseline (P<0.05)
b. Significant difference with after intense exercise (P<0.05)
c. Significant difference with passive recovery (P<0.05)
d. Significant difference with active recovery (P<0.05)

As shown in the figure 2, the results indicated that CRP levels increased immediately after the intense exercise in all three groups (P<0.05). CRP levels decreased after 15 min passive recovery, active recovery and contrast water immersion compare to after the intense exercise (P<0.05); however, Bonferroni Post hoc test indicates that no significant differences were observed between three types of recovery.

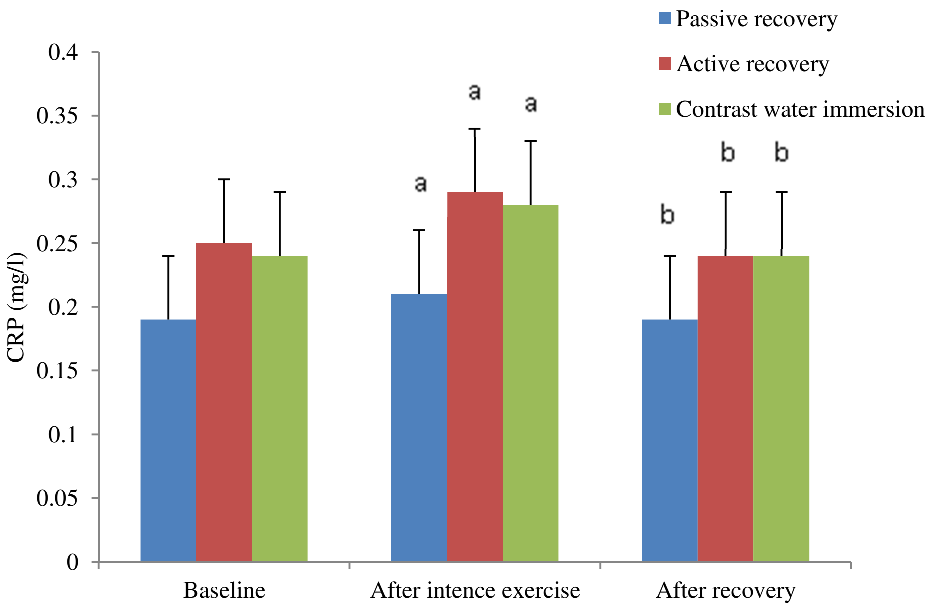

Figure 2. Changes of CRP levels after passive recovery group, active recovery and contrast water immersion

a. Significant difference with baseline (P<0.05)

b. Significant difference with after intense exercise (P<0.05)

4. Discussion

The result of three effective recovery programs in removing the accumulated blood lactate of table tennis players showed that the contrast water immersion significantly eliminates lactate compared to the other methods of the recovery. Also results demonstrated that there was no significant difference between the 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 (19). The time in which the entered lactate to the body decreases in the blood serum or plasma is called as half-life of lactate (20).

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 (21). The results demonstrated that the blood lactate levels increased immediately after the intense exercise in all three groups but no significant differences were observed between the passive recovery and the active recovery. Previous studies indicated that 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 (22). These discrepant results may be attributed to time of blood sampling, subjects' population and type of active recovery.

The results indicated that blood lactate levels were lower after the contrast water immersion than the passive recovery and active recovery ($P<0.05$). Contrast water immersion has been considered to enhance athletic recovery through stimulating area specific blood flow, increasing circulation, relieving stiffness and pain, increasing range of motion and reducing delayed onset of muscle soreness (1,9). One reason behind such possible benefits to recovery is that contrast water immersion may mimic one of the mechanisms attributed to active recovery without the same energy demand (18). That is, recovery using active low- intensity exercise is considered to enhance recovery compared to passive modalities (23) by alternating muscular contractions acting in a pumping/squeezing action (14). Low intensity repetitive mechanical squeezing by the muscle during contraction-relaxation may increase the translocation and removal of metabolites such as lactate and reduce intracellular fluid volume (24). Alternating vasoconstriction and vasodilation, is thought to act in a comparable way to muscle pumping, increasing blood flow and metabolite removal, enhancing recovery (1).

Our results demonstrated that CRP levels increased immediately after the intense exercise in all three groups ($P<0.05$). Although CRP levels decreased after 15 min passive recovery, active recovery and contrast water immersion compare to after the intense exercise ($P<0.05$); no significant differences were observed between three types of recovery. Contrast therapy has been considered to enhance athletic recovery through stimulating area specific blood flow, increasing blood lactate removal, reducing inflammation and edema, stimulating circulatory relieving stiffness and pain, increasing range of motion and reducing delayed onset of muscle soreness (1,9). When a large portion of the body is immersed, hydrostatic pressure acts on the body's fluid within the immersed region. Fluids from the extracellular space move into the vascular system reducing exercise-induced increase in muscular volume and reducing soft tissue inflammation (14).

5. Conclusion

According to results of this study, contrast water immersion had significantly reduced the blood lactate level higher than the passive and active recoveries, however for CRP, no significant differences were observed between three types of recovery. These results were suggested contrast water immersion could be a beneficial method for table tennis players as one of the suitable types of recovery.

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Conflict of interests: No conflict of interests amongst authors.

References

[1] Cochrane DJ. Alternating hot and cold water immersion for athlete recovery: a review. Physical Therapy in Sport 2004; 5: 26-32.

[2] Malm C, Sjodin TL, Sjoberg B, Lenkei R, Renstrom P, Lundberg IE, et al. Leukocytes, cytokines, growth factors and hormones in human skeletal muscle and blood after uphill or downhill running. J Physiol 2004; 556: 983-1000.

[3] Peake JM, Nosaka K, Muthalib M, Suzuki K. Systemic inflammatory responses to maximal versus submaximal lengthening contractions of the elbow flexors. Exerc Immunol Rev 2006; 12: 72-85.

[4] Ahmaidi S, Granier P, Taoutaou Z, Mercier J, Dubouchaud H, Prefaut C. Effects of active recovery on plasma lactate and anaerobic power following repeated intensive exercise. Med Sci Sports Exerc 1996; 28: 450-456.

[5] Baldari C, Videira M, Madeira F, Sergio J, Guidetti L. Lactate removal during active recovery related to the individual anaerobic and ventilatory thresholds in soccer players. Eur J Appl Physiol 2004; 93: 224-230.

[6] Howatson G, Goodall S, Someren KA. The influence of cold water immersions on adaptation following a single bout of damaging exercise. Eur J Appl Physiol 2009; 105: 615-621.

[7] Martin NA, Zoeller RF, Robertson RJ, Lephart SM. The comparative effects of sports massage, active recovery, and rest in promoting blood lactate clearance after supramaximal leg exercise. J Athl Train 1998; 33: 30-35.

[8] Gill ND, Beaven CM, Cook C. Effectiveness of post-match recovery strategies in rugby players. Br J Sports Med 2006; 40: 260-263.

[9] Coffey V, Leveritt M, Gill N. Effect of recovery modality on 4-hour repeated treadmill running performance and changes in physiological variables. J Sci Med Sport 2004; 7: 1-10.

[10] Dowzer CN, Reilly T, Cable NT. Effects of deep and shallow water running on spinal shrinkage. Br J Sports Med 1998; 32: 44-48.

[11] Barnett A. Using recovery modalities between training sessions in elite athletes: does it help? Sports Med 2006; 36: 781-796.

[12] Lattier G, Millet GY, Martin A, Martin V. Fatigue and recovery after high-intensity exercise. Part II: Recovery interventions. Int J Sports Med 2004; 25: 509-515.

[13] Sanders J. Effect of Contrast-temperature Immersion on Recovery from Short-duration Intense Exercise. Unpublished thesis, University of Canberra, Canberra, 1996.

[14] Wilcock IM, Cronin JB, Hing WA. Physiological response to water immersion. Sports Med 2006; 36: 747-765.

[15] Suzuki M, Umeda T, Nakaji S, Shimoyama T, Mashiko T, Sugawara K. Effect of incorporating low intensity exercise into the recovery period after a rugby match. Br J Sports Med 2004; 38: 436-440.

[16] Thiriet P, Gozal D, Wouassi D, Oumarou T, Gelas H, Lacour JR. The effect of various recovery modalities on subsequent performance, in consecutive supramaximal exercise. J Sports Med Phys Fitness 1993; 33: 118-129.

[17] Farhi LE, Linnarsson D. Cardiopulmonary readjustments during graded immersion in water at 35 degrees C. Respir Physiol 1977; 30: 35-50. 7

[18] Nakamura K, Takahashi H, Shimai S, Tanaka M. Effects of immersion in tepid bath water on recovery from fatigue after submaximal exercise in man. Ergonomics 1996; 39: 257-266.

[19] Plowman SA, Smith DL. Exercise physiology for health, fitness and performance, Lippincott Williams & Wilkins, 3rd Edition, 2011.

[20] Lagutchik MS, Ogilvie GK, Wingfield WE, Hackett TB. Lactate kinetics in veterinary critical care: a review. J Vet Emerg Critic Care 1996; 6: 81-95.

[21] Fox E, Gisolfi, Robinson S, Turrell E. Effect of aerobic work performed during recovery from exhaustive work. Europ J Appl Physiol 1989; 21: 1767-1772.

[22] Flanagan W. Recovery strategies for surf life saving athletes in training and competition" specific discipline board paddling", 2006. Available online at: https://apps.sls.com.au/sites/sls.com.au/files/Recovery-stratagies-Wayne-Flanagan.pdf.

[23] Connolly DA, Brennan KM, Lauzon CD. Effects of active versus passive recovery on power output during repeated bouts of short term, high intensity exercise. J Sports Sci Med 2003; 2: 47-51.

[24] Signorile JF, Ingalls C, Tremblay LM. The effects of active and passive recovery on short-term, high intensity power output. Can J Appl Physiol 1993; 18: 31-42.