THE EFFECTS OF DIFFERENT RECOVERY CONDITIONS ON BLOOD LACTATE CONCENTRATION AND PHYSIOLOGICAL VARIABLES AFTER HIGH INTENSITY EXERCISE IN HANDBALL PLAYERS

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Abstract
The aim of this study was to determine the effects of different active vs. passive recovery on blood lactate concentration after high intensity exercise in handball players. Ten male students (age: 22.4 ± 2.1 years; body mass index: 21.6±1.2 kg/m²; percent body fat: 14.5±2.1) performed ten 30-meters shuttle run sprints with a 30 second passive recovery between repetitions for production lactate at a similar time of the four days. Four recovery trails were used to determine efficient recovery method in handball players. Statistical analyses revealed a significant difference between active and passive recovery conditions. There was a significant difference between walking with running and jogging recovery conditions (p = 0.012 and p = 0.002 respectively). There were no significant differences between the jogging and running recovery models (p = 0.576). Consequently, the results indicated that, higher intensity recovery might have a greater capacity to remove lactate in handball players.

Keywords: active recovery, passive recovery, blood lactate, handball players

Introduction
Modern handball is a fast game and the rules allow interchanging of players at any moment during a match and after a goal has been scored, the referee restarts the game as soon as an attacking player is in possession of the ball at the centre line, independent of the defenders position on the court. In team handball, matches are characterized by repeated accelerations, sprints, jumps, change of directions and technical movements in very short time and with an order determined by the tactical situation. At elite level, regular player actions, such as tackles, feints and shots, have to be carried out with maximal intensity to overcome opposition and be successful.

Therefore, handball is a sport characterized by the involvement of both aerobic and anaerobic metabolic pathways and high levels of blood lactate may sometimes be observed during a match (Ronglan et al., 2006). The ability to repeat high-intensity efforts may be of importance for handball players. Several studies have suggested that lactate accumulation is associated with muscular fatigue (Ahmaidi et al., 1996; Bond et al., 1991). Also, it was revealing that The ability to perform maximally during repeated exercise bouts is influenced by the nature of both exercise and recovery periods (Greenwood et al, 2008). Therefore, in intermittent high-intensity exercise like handball recovery model is so importance. Lactate is removed from the blood through a combination of methods. Lactate is metabolized by the heart, brain and liver through oxidation (Bonen et al., 1979). Previous reports have indicated that active recovery is better than passive recovery for blood lactate disappearance (Ahmaidi et al., 1996; Monedero & Done, 2000; Dodd et al., 1984).

Research has found significant reductions in lactate during short duration low intensity active recoveries when compared with passive recovery involving three or more bouts (Dodd et al., 1984). Also, it has been shown that blood lactate concentrations decrease more rapidly during an active recovery performed at 30-70% maximal O2 consumption (VO2max) (Bonen et al., 1979; Dodd et al., 1984). This range (30-70% VO2max) is very wide and work rate expressed in percent of VO2max would not be comparable among subject. Therefore, in handball players exercise intensity should be defined in relation to the individual heart Rate. Also, to our knowledge, no commonly agreed strategies or optimal intensity of active recovery for clearing accumulated lactate in handball players. So the knowledge of the most efficient work rate for lactate removal could be useful not only to optimize the strategy during a handball game, but also to design the athlete training session. Additionally, lactate can induce peripheral venous blood pooling, reduce cardiac filling, and impair cardiac pre-load and stroke volume (Crisafulli, 2006).

Therefore, we expect best method for recovery and removal lactate can affect on several physiological variables, like the heart rate (HR), Systolic blood pressure (SBP), diastolic blood pressure (DBP) and rate-pressure product (RPP), that have important role in heart function. With regard to controversy among little studies results about optimal recovery after severe repeated exercise and its efficient effects on athlete performance and physiologic response; the aim of this study was to examine the different recovery methods after high intensity shuttle run sprints for removal lactate and change blood pressure and RPP in handball players.
Methods

Subjects
Physiological characteristics of the subjects are presented in Table 1. Ten male students volunteered for this study. All participants were members of the varsity handball team at the University of Guilan. Before the study began, all the experimental procedures, benefits and risks of the study were explained to the participants, and they each provided written informed consent. The study was approved by the Human Investigation Committee of the University of Guilan. All subjects were in good health and were not taking medication, amino acids, or other drugs, including anabolic doping agents that could influence the experimental protocol. Subjects completed a one day food diary on the day before their first test, and repeated this diet before the subsequent trials. In addition, participants were asked to refrain from exhaustive exercise within 48 hours and avoid food and fluids except water within two hours of all laboratory visits.

Table 1 (Mean ±SD) values of the subjects’ characteristics.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Age (years)</th>
<th>Height (m)</th>
<th>Body Mass (kg)</th>
<th>Body mass index (kg/m²)</th>
<th>VO2max (ml kg⁻¹ min⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>22.40 ±2.10</td>
<td>1.77 ±0.13</td>
<td>69.50 ±3.50</td>
<td>21.60 ±1.20</td>
<td>51.4 ±8.0</td>
</tr>
</tbody>
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Study design and measurement
The subjects with the procedures and to determine their VO2max and anthropometric measurements. The test for the determination of VO2max was performed on a treadmill (Technogym, Italy) with Bruce protocol. The skinfold-thickness was measured using Lange caliper that make use of the Bruce protocol. The skin fold-thickness was performed on a treadmill (Technogym, Italy) with jogging with 55-65% HRmax 3) running 65-70%

Testing Procedures
Participants followed a ten minute warm-up which comprised of light jogging and stretching performed ten 30-meters shuttle run sprints with a 30 second passive recovery between repetitions for production lactate. Before the initial shuttle run and end of test, lactate concentration analyzed with a scout portable lactate analyzer (Roche Diagnostics, Mannheim, Germany). Each subject was required to perform four different shuttle run sprints at a similar time of the day. The 4 recovery trials were investigated as 1) walking with 45-55% HRmax 2) jogging with 55-65% HRmax 3) running 65-70% HRmax and 4) passive.

During exercise and recovery HR was monitored by pulsometer (PM 80 Germany) Also blood pressure was monitored before the test and at the end of the exercise by sphygmomanometer and stethoscope (ALPK2 Japan).

Statistical analysis
All analyses were performed using the SPSS software (version 16.0, Chicago, USA). Data are reported as means and standard deviation (SD). The distribution of the data was analyzed by the Shapiro–Wilks test, and the results showed a normal Gaussian distribution. ANOVA for repeated measures was used to detect significant difference between groups and Post-hoc analysis of significant differences was investigated using the Bonferroni test. A level of significance of P<0.05 was used throughout this study for all the tests.

Results

Blood lactate during recovery
Changes in blood lactate concentration in the 4 recovery conditions are presented in figure 1. Mean blood lactate concentrations on baseline and immediately after exercise were the approximately same in the 4 trials (p = 0.467 and p = 0.952 respectively). Statistical analyses revealed a significant difference between active and passive recovery conditions. Significant changes in blood lactate concentration appeared on after the all recovery (p = 0.001). There was a significant difference between walking with running and jogging recovery conditions (p = 0.012 and p = 0.002 respectively). There were no significant differences between the jogging and running recovery models (p = 0.576). But, the blood lactate concentration following recovery at running was lower than for the other two active recovery conditions.

Figure 1. Change in blood lactate concentration in the four recovery conditions. * Significant (P<0.05) difference between before- and after-recovery values for each trial group.

SBP, DBP and RPP during recovery
SBP and DBP in the 4 conditions are shown in figure 2. Blood pressure in baseline and immediately after exercise were close together for the 4 conditions (SBP: p = 0.734 and p = 0.657; DBP: p = 0.306 and p = 0.135 respectively).
Statistical analyses revealed a significant difference between active and passive recovery conditions ($p = 0.005$). Significant different and DBP appeared on after the all recovery ($p = 0.001$). There was a significant difference in SBP between walking and jogging recovery conditions ($p = 0.007$ and $p = 0.01$ respectively). But, There were no significant differences between the walking with jogging and running ($p = 0.449$ and $p = 0.155$ respectively). Also, the SBP and DBP following recovery at passive recovery were lower than for the other three recovery conditions.

Figure 2. SBP at baseline, before and after four recovery conditions. *Significant ($P<0.05$) difference between before- and after-recovery values for each trail group

Statistics and conclusion

This study demonstrated that active recovery after 30-meters shuttle run sprints led to a faster clearance of accumulated blood lactate than passive recovery in handball players. Also, this study showed that the decrease in accumulated blood lactate after 30-meters shuttle run sprints was more effective when followed by active rather than passive recovery. This confirms previous studies showing that active recovery clears blood lactate faster than passive recovery from the blood (Ahmaidi et al., 1996; Monedero & Done, 2000; Dodd et al., 1984). Our study have shown that active recovery for clearing lactate may be most effective in the range 55-70% HR$_{max}$. We observed in handball players that Lactate decline was more efficient during recovery at 55-65 and 65-70% HR (without significant difference between these work rates), but active recovery at 55-60% and 65-70% of HR were also more effective than 45-55% of HR. This result is in agreement with previous studies showing that active recovery for clearing lactate may be most effective in the range 25-63% of V0$_{2max}$ (Boileau et al., 1983). Also, its consistent with previous studies that lactate removal occurs more effectively during mild to moderate exercise recovery intensities (Baldari et al., 2004). But, recent finding is inconsistent with few previous studies showing that blood Lactate concentrations decrease more rapidly if light exercise is performed during the recovery phase (Hermansen & Stensvold, 1972; Gladden, 1991). It has been shown that optimum intensity of recovery exercise to promote blood lactic acid removal is around 30% to 40% of V0$_{2max}$ (Dodd et al., 1984). Our result also showed that for trained men higher intensity recovery might have a greater capacity to remove lactate. Therefore, blood lactate concentration during exercise and recovery is a complex event influenced by a combination of lactate production by the exercising muscle, blood flow, and lactate uptake and oxidation by the liver, heart, and skeletal muscle (Bonen et al., 1979). As exercise intensity increases, blood flow to tissues that can oxidize lactate, especially to the slow-twitch fibers of skeletal muscles where lactate oxidation occurs is increased (Greenwood et al., 2008; Gladden, 2000).
Blood lactate can be altered in femoral artery blood flow and vascular tone during recovery (Crisafulli, 2006). Pervious study demonstrated that blood lactate levels remained elevated during the period of persistent vasodilatation after the exercise bout (Crisafulli, 2006). Some physiological variables, such as the HR, BP and RPP have important index for indicator of the heart work during exercise (Duncker & Bache, 2008). RPP (usually called the doubled-product) is an index of myocardial oxygen consumption during exercise and calculated by multiplying the SBP by the HR (Duncker & Bache, 2008; Gobel et al., 1978). This study showed that the SBP, DBP and RPP significantly increased immediately after exercise. Also, it was observed that passive recovery method was more effective for decrease in SBP, DBP and RPP. It has been previously reported that moderate and high intensity exercise bouts produce highest increases in RPP during exercise and fail to reduce RPP below baseline during the recovery period (Duncker & Bache, 2008; Gorman & Feigl, 2012). It also demonstrated that the decrease in blood pressure during recovery is more pronounced following intense exercise (Raglin et al., 1993) for example, Piepoli et al. (1994) observed that maximal exercise provide a post-exercise blood pressure fall in young normotensive humans. So, recovery intensity plays a role in hemodynamic, thermoregulatory and neural responses. Increase in sympathetic activity and attenuated vagal reactivation affect on heart rate, ventricular wall tension and heart contractility maybe cause to increase in SBP and DB in active recovery conditions (Chen & Bonham, 2010). Some studies suggest that the increase in heart rate accounts for 55-70% of the increase in myocardial oxygen consumption during exercise (Duncker & Bache, 2008). Moreover, lactate can induce peripheral venous blood pooling, reduce cardiac filling, and impair cardiac pre-load and stroke volume (Crisafulli, 2006). So, one reason for decrease in BP in passive recovery maybe is result of postpone lactate removal. In conclusion, this study demonstrated active recovery for clearing lactate of handball players was most effective in the range of 55-70% HRmax. And passive recovery condition was more effective for decrease in SBP, DBP and RPP. But, in this study performance of handball players wasn’t been measured in competition and real training due to uncontrolled condition. Therefore it’s unclear that which method is most appropriate for handball match. This issue need to more studies in future.

References


Arazi, H. et al.: The effects of different recovery conditions on blood lactate... Sport Science 5 (2012) 2: 13-17


**UČINAK RAZLIČITIH UVJETA OPORAVKA NA KONCENTRACIJU LAKTATA I FIZIOLOŠKE VARIJABLE NAKON VISOKOG INTENZITETA VJEŽBANJA RUKOMETAŠA**

**Sažetak**

Cilj ovog istraživanja bio je utvrditi utjecaj različitih (aktivnog i pasivnog) oporavka na laktate nakon visokog intenziteta vježbanja rukometaša. Deset učenika (dob: 22,4 ± 2,1 godina, indeks tjelesne mase: 21,6 ± 1,2 kg/m2; postotak masnog tkiva: 14.5 ± 2.1) izvodilo je deset ponavljanja 30-metarskog trčanja shuttle-run testa sa 30 sekundi pasivnog oporavka između ponavljanja za „proizvodnju“ laktata u slično vrijeme uzastopna četiri dana. Četiri pravca oporavka su korišteni za određivanje učinkovitosti oporavka rukometaša. Statistička analiza pokazala je značajnu razliku između aktivnih i pasivnih uvjeta oporavka. Značajna je razlika između uvjeta oporavka kod hodanja s trčanjem i joggingom (p = 0,012 i p = 0,002 respektivno). Nije bilo značajne razlike između metoda oporavka joggingom i trčanjem (p = 0,576). Dakle, rezultati pokazuju da, veći intenzitet oporavka možda pokazuje veći kapacitet za uklanjanje laktata kod rukometaša.

**Ključne riječi:** aktivni oporavak, pasivni oporavak, laktati u krvi, rukometaši

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