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ПРОДВИЖЕНИЕ НАШЕГО СПОРТА ЧЕРЕЗ ЗНАНИЕ

PROGRESO PARA NUESTRO DEPORTE MEDIANTE CONOCIMIENTO

THE ACUTE EFFECTS OF RESISTANCE EXERCISE WITH BLOOD FLOW AND RESPIRATORY RESTRICTION ON BLOOD LACTATE AND GROWTH HORMONE IN COLLEGIATE WRESTLERS

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ABSTRACT

Resistance activity with new methods of exercise such as blood flow and respiration restriction has been performed at a lower intensity in pursuing various physiological responses. The main purpose of this research was to study the effect of blood flow and respiratory restriction on blood lactate concentration and growth hormone in the acute response to resistance exercise in collegiate wrestlers. A counter-balanced design was used in which 8 collegiate wrestlers (mean age 26.87 ± 4.7 years and body mass index 25.26 ± 2.49 kg/m²) were randomly assigned in three conditions including: control (80%1RM) and resistance exercise with blood flow and respiratory restriction (30%1RM). Four sets of squats were used as the resistance exercise. Blood samples were collected before and immediately after exercise. The data were analyzed by repeated measure ANOVA using SPSS software (version 19) with a significance level of $p < 0.05$. All three types of exercise caused a significant increase in lactate and growth hormone immediately after the exercise, but no significant difference was observed between the groups. The results of this study indicated that resistance exercise with restriction of blood flow and respiration can lead to increased metabolic and hormonal responses. This research also confirms the effectiveness of this type of exercise and satisfies the goals expected from high intensity exercises.

Keywords: KAATSU Training, Weight Training, Training Mask

INTRODUCTION

Resistance training is an effective training method for increasing metabolism and secretion of anabolic hormones. This can improve the growth of skeletal muscle. Resistance exercise stimulates the hormone response and affects the endocrine system in the long and short term. This acute hormonal reaction is the most important element for growth of muscle mass (Kawamori & Haff, 2004). Moreover, the changes in the central and lateral nervous system occur to enable the activation of motor units for the production of the special force. Evidence shows that high intensity exercises affect the concentration of metabolic levels and hormones such as growth hormones, and their secretion is correlated with exercise intensity (Pearson, Faigenbaum, Conley & Kraemer, 2000). Resistance exercise has an important effect on public health, prevention and even treatment of many diseases of adult age (aging) and is often prescribed to enhance the ability of an individual to reduce and prevent injury associated with increasing age (such as osteoporosis) (Abe, Yasuda, et al., 2005). Therefore, there is a need for designing exercises according to safe and effective methods for the elderly, injured athletes, and other groups that require increased muscular strength. However, it is not necessary to tolerate these hard exercises (high intensity). Studies show that if an exercise has been programmed with less than maximum intensity (less than 50% of a maximal repeat), but with limited blood flow, low pressure input on the joints and ligaments, will result in less damage. However, in the same state, it also has enough stimulation to increase muscle size and strength (Fujita, Brechue, Kurita, Sato, & Abe, 2008). The American College of Sports Medicine (ACSM) recommends a training intensity of 70% to 85% of a maximal repeat (1RM) in order to achieve goals such as increased growth hormone and protein synthesis (Ahtainen, Pakarinen, Alen, Kraemer & Häkkinen, 2005; H. Takano et al., 2005). Research has shown mechanical stresses caused by high intensity resistance exercises (more than 70% of 1RM). It increases the concentration of metabolic stress indicators such as lactate and growth hormone due to resistance training, which itself leads to increased strength and muscular hypertrophy (Fujita et al., 2008; Takarada et al., 2000). Blood obstruction exercises include reducing muscle blood flow by usually using a device such as a blood pressure cuff. It should be noted that closure of the cuff takes place in the proximal area of the target tissue to limit blood flow. This method of training, despite having low intensity activities (10% to 30% of maximum working capacity) provides a positive training adaptation and can be a unique and beneficial method in the medical field (Stand, 2009). Performing resistance training under systemic hypoxia increases lactate levels and secretion of hormones such as growth hormone, insulin-like growth factor and testosterone (Nishimura et al., 2010; Scott, Slattery, Sculley, & Dascombe, 2014). Research has shown that this type of training improves the aerobic and anaerobic systems, and is itself a factor in increasing power (Hamlin, Marshall, Hellemons, Ainslie, & Anglem, 2010; Meeuwssen, Hendriksen & Holewijn, 2001). Unlike topical hypoxia which affects a particular part of the body (upper and lower extremity), systemic hypoxia allows large muscle groups or the total body to be affected (Scott et al., 2014). Therefore, numerous studies have been done on the effects of these exercises on metabolic and hormonal responses. Following a resistance exercise session with limited blood flow increased the growth hormone significantly after ten minutes (S. Fujita et al., 2007). Resistance training under hypoxic conditions was

shown to increase metabolites like lactate and hormones such as testosterone and growth hormone (Kon et al., 2010). In addition, similar changes from local and systemic hypoxia have been reported (Laurentino et al., 2012; Takarada, Sato, & Ishii, 2002). However, the effects of blood flow restriction are greater than systemic hypoxia (Manimmanakorn, Hamlin, Ross, Taylor, & Manimmanakorn, 2013). Even so, it has recently been shown that exercises under systemic hypoxia have the same response to blood flow restraint, but it is better to use exercises for circulatory restriction for elderly people and systemic hypoxia for athletes (Scott, Slattery, Sculley & Dascombe, 2014). It is worth noting that the importance of studying exercise methods (circulatory and systemic hypoxia limitation) is evident when used as a complementary exercise method to improve physical fitness. These exercises can be applied at a low load to achieve maximum positive adaptations with the least possible damage to heavy loads for wrestlers. In addition, since the anaerobic glycolysis system is the main supplier of energy in wrestling, these types of exercise may have positive effects, such as increased anaerobic capacity and lactate tolerance. Therefore, this research aimed to study the effect of blood flow and respiratory restriction on blood lactate concentrations and growth hormone in the acute response to resistance exercise in collegiate wrestlers.

METHODS

Participants were eight collegiate wrestlers (age = 26.87 ± 4.7 yrs, height = 174.5 ± 9 cm, weight = 77.50 ± 1.4 kg, BMI = 25.26 ± 2.49 kg/m²) were selected in a natural state of health (interviewed by physician in terms of records of illness and physical impairment). After the final confirmation, the participants filled out a specific questionnaire about their physical activity level, record of disease and consent, these people were then selected as the sample and were subjected to intervention. After ensuring public health and the general ability to perform the sport protocol, the subjects attended the laboratory a week before performing the original protocol in order to get familiar with the exercise protocol. The University of Guilan ethics committee approved the study.

Instruments-Tests, Procedures & Research Design In this study, a counter-balanced study design was used in which the subjects were randomly assigned for three consecutive weeks in three conditions including: control, resistance exercise with blood flow restriction (BFR), and resistance exercise with respiratory restriction using a mask. Each week, the groups changed their roles in order to experience all three conditions. Between the three exercises of the blood flow restriction group, with systemic hypoxia and control, one week was discontinued to eliminate the metabolic and hormonal effects of the first training. The main exercise protocol we had for all three groups was the implementation of four sets of the squat, which included, a set of 20 repetitions with 30 seconds of rest between sets with 10% to 30% of peak maximum power and three sets with 15 repetitions and 30 seconds of rest between the sets, totaling 65 repetitions (Takashi Abe, Kearns, & Sato, 2006; Kraemer & Ratamess, 2005). Since the pressure on the area should exceed the systolic pressure of the same area, the pressure used was 1.3 times more than the systolic pressure for the legs. Therefore, the systolic pressure prescribed for the legs is about 160 to 200 mmHg. However, during the whole exercise, blood flow was limited, even at resting intervals between sets. The intensity of the resistance used by the subjects was 30% of their 1RM. To equalize the time for resistance exercise, for all subjects, the contraction period was recorded by a chronometer. Each contraction lasted 4 seconds, that includes 2 seconds down and 2 seconds up (Abe, Hinata, Koizumi & Sato, 2005; Reeves et al., 2006). In addition, we created a systemic hypoxia condition with a training mask that was on the examiner's face during the entire training stage (warming up, training) (Etheridge et al., 2011). Subjects were asked not to take caffeine at least 24 hours before the main activity. In addition, the use of high-fat foods was also restricted, and participants were asked not to take food or liquids other than water for two hours before the start of each test session. All practice sessions took place in the evening (between 5 to 7 or 4 to 6 pm), and at least 4 hours after the lunch time for subjects (Reeves et al., 2006). In each session, the subjects warmed up for 10 minutes with stretching movements. Moreover, to monitor the intensity of exercise, the Borg scale of perceived exertion was used.

According to the research objectives, blood sampling was collected in two stages. 5 mm of sample of venous blood was taken from the antecubital vein of the subjects in a sitting position at each time before the workout and immediately after completion of the training. In order to avoid blood clotting, the samples were transferred heparinized collection tubes (F.L. Medical, Padova, Italy). To separate plasma, the sample was centrifuged at 3000 RPM for 5 minutes, and stored at -20 degree Celsius until the end of the process. Lactate was measured with a Mindray BS-380 Chemistry Analyzer, (Mindray Bio-Medical Electronics Co, Shenzhen, China) using a Greiner Kit (Greiner Diagnostic GmbH, Bahlingen, Germany) which has a sensitivity of 0.1 milligram per deciliter. Growth hormone was measured with a Roche kit and Electrochemiluminescence (ECL). Body weight with minimum coverage and without shoes was measured by a calibrated lab scale (CAMRY 9015), and height without shoes was measured by a height gauge while standing next to the wall. BMI was calculated using the formula (weight in Kg, divided by height in m²). To calculate waist-to-hip ratio (WHR), the perimeter of waist in its most slender part and hip in its widest part was measured. WHR was obtained by dividing these two measurements. Fat percentage and fat-free masses for the subjects' body was

measured by a Inbody 270 body composition analyzer (InBody, Co., Seoul, South Korea). To understand the blood pressure of subjects, a mercury pressure meter (Alpikado V-300) was used.

Statistical Analysis The data were analyzed using SPSS software version 19. In order to determine the normal distribution of data, the Shapiro-Wilk test was used and to determine the response of lactate and GH, a two-way analysis of variance with repeated measures (2×3) was used. The level of α was 0.05 in all statistical analyses.

RESULTS

Values were expressed as mean and standard error (SEM). The sample characteristics are described in Table 1. Fig. 1 shows the values assigned to the blood lactate; Fig. 2 shows the results of growth hormone. All exercise sessions presented higher values for blood lactate and growth hormone ($P < 0.05$) in comparison with resting position.

Table 1 Sample characteristics* (N = 8)

Age (years)	26.87±4.7
Height (cm)	174.5± 9
Weight (kg)	77.50±1.4
Body mass index (kg/m ²)	25.26±2.49
Body fat (Percent)	19.84±3.17
Fat free mass (kg)	62.52±7.76
Resting systolic blood pressure	118.1±7.52
Resting diastolic blood pressure	71.25±6.4

*Values are mean ± SEM

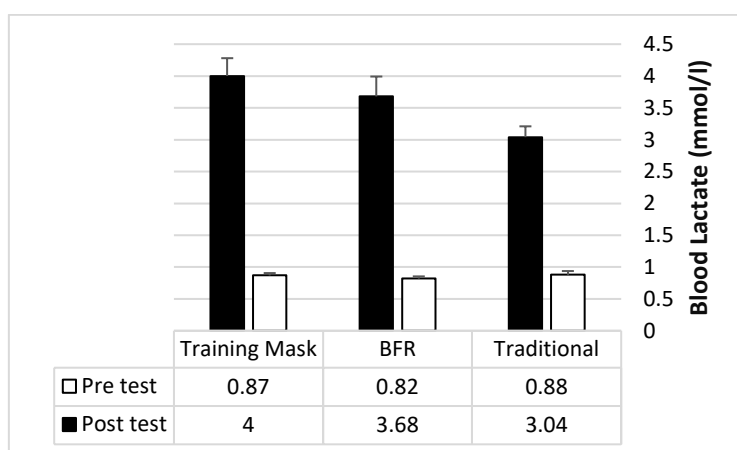


Figure 1 Measurement of blood lactate. No significant difference was seen between groups ($p=0.140$, $F=2.274$). However, significant difference was seen intragroup for pre & post-test in all three groups (in traditional/ control group $p=0.001$, $F=93.526$, in BFR, $p=0.002$, $F=22.584$ and in respiratory restriction, $p=0.001$, $F=85.071$).

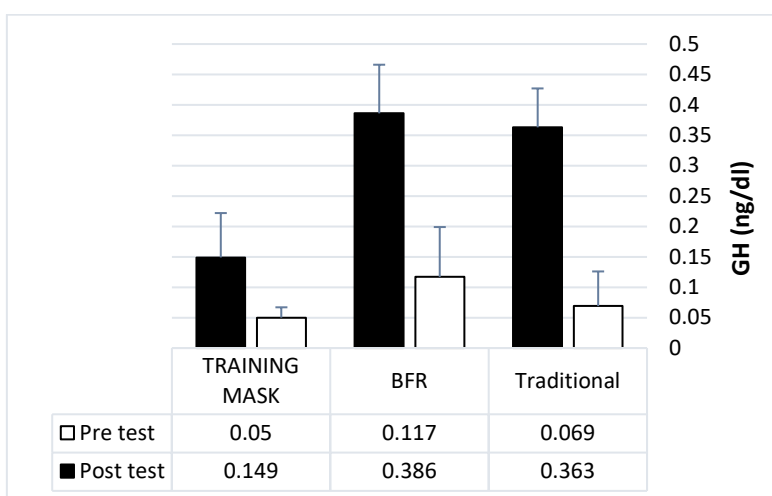


Figure 2 Measurement of growth hormone. No significant difference between groups was seen ($p=0.098$, $F=2.751$). But significant difference for pre & post-test in all three groups was observed (in traditional/ control group, $p=0.024$, $F=8.209$, in BFR, $p=0.047$, $F=5.805$ and in respiratory restriction group, $p=0.042$, $F=6/155$).

DISCUSSION

The results of this study showed that the implementation of resistance activity with different training methods significantly increased the level of lactate and growth hormone levels of collegiate wrestlers compared to pre-exercise levels. Blood lactate and GH hormone levels were not significantly increased during exercise with limited blood flow and respiration compared with the other group (control). Perhaps the difference between groups would be less if the duration of the activity session was increased by adding more exercises or exercising more intensely, because it requires higher levels of exercise intensity to have an effective GH activity (Kraemer & Ratamess, 2005; Manini & Clark, 2009). In addition, the significant increase in lactate in the training groups immediately after the activity was an important result of this study. Research has shown that resistance activity is more dependent on anaerobic metabolism than aerobic metabolism which can be executed without limitation of high intensity or with the limitation of low intensity. As a result, lactate is accumulated in the target muscle tissue and leads to increased release of GH from the pituitary gland (Goto, Ishii, Kizuka, & Takamatsu, 2005). The increase of the above variables (lactate and GH) has been observed due to high or low intensity resistance with limited blood flow and respiration. In a study performed on 12 subjects lactate in the control group (knee extension with 20% 1RM) did not change significantly after exercise compared to another group (knee extension with equal intensity to closure of the cuff) (Takarada et al., 2000). The reason why lactate does not increase in a group without blood flow restriction in this research can be attributed to the athletic subjects, the low intensity of activity and the number of more sets. Furthermore, in a study with low intensity resistance training, there was no significant increase in the blood flow restriction group immediately after activity in GH but there was a significant increase only 10 minutes after activity without restriction (Takano et al., 2005). Findings of this study did not match the results of the present study. But why GH has not increased in the group with limited blood flow is possibly because of the low-intensity activity. In research by Suga et al, they studied intracellular metabolism during low intensity exercises with restricted blood flow. The results showed that the decrease of pH in the restriction group was more than the unrestricted group. They found that by exercising with a low intensity with limited, metabolic stress in skeletal muscle would be significantly increased but overall, its size is less than intense strength training (2009). In another study, based on intragroup changes, GH was significantly increased in the restriction group, and an interesting point was that, not only was the GH in the unrestricted group was not increased, but actually decreased (Leite, Reis, Colnezi, Souza, & Ferracini, 2015). To some extent, the discrepancy in the findings of the Leite with the present results can be attributed to how the exercise was performed the composition of the subjects, and the intensity of the training. The low number of sets (the ratio of 2 to 4), the high number of movements per set (the ratio of 30 to 15), and the different subjects (soccer boys) can be considered as a factor in the difference between the present research and that of Leite. Scott et al (2014) studied the effect of resistance training in systemic hypoxia conditions on metabolic stress and hormonal responses. They showed that resistance training in systemic hypoxia increased the level of lactate and GH relative to normal conditions (Normoxia). This corresponded with the results in the present study. In hypoxic conditions, the body's access to oxygen decreases; in this case the body increases anaerobic metabolism which leads to an accumulation of lactate in the muscle and blood. This can be a stimulant for the anterior pituitary to secrete GH. The results in the present study justify the use of a training mask. According to previous studies the low-intensity resistance exercise increases muscle mass and as a consequence strength increases. Research has found that hypoxia promotes the secretion of anabolic hormones in bodybuilders. In a study, eight men participated in two experimental groups (low intensity resistance training in normoxia and low intensity resistance exercises in hypoxia conditions). Lactate and GH increased in both groups, but in the second group it was significantly more than the first group. These results indicate that low intensity resistance activity in hypoxic conditions increases the metabolic and hormonal responses to the normobaric conditions. A study showed that lactate and GH can significantly increase in high intensity exercises and in hypoxia conditions (Kon, Ikeda, Homma, & Suzuki, 2012). However, these findings suggest that severe hypoxia can be an important factor in increasing GH in response to exercises at high speeds (Kon, Nakagaki, Ebi, Nishiyama, & Russell, 2015). Our findings also showed that low-intensity activity in hypoxia (local and systemic) leads to significant increases in lactate and GH.

Resistance exercises with restricted blood flow and respiration increase metabolic stress and hormonal response. Also, in most studies the effects of exercises with BFR have been reported more than systemic hypoxia. Some studies have also shown that systemic hypoxia conditions have similar responses BFR in young adult athletes. However, it is still uncertain which one of the exercises could be more effective in promoting sports goals. Therefore, it is suggested that in future studies, comparisons between resistance, speed and endurance exercises with and without restriction of blood flow and respiration and their metabolic and hormonal changes should be investigated.

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