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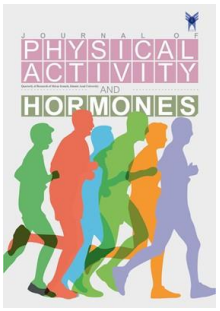

Comparison of the effect of resistance training with and without muscle blood flow restriction on the plasma level of LDH and CPK of beginner men bodybuilders

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Abstract

Introduction: This study's purpose was to compare traditional resistance training and resistance training with blood flow restriction (Katsu training) on muscle damage and the level of CPK and LDH in men bodybuilders.

Material & Methods: In this study, 40 healthy volunteer male bodybuilders were randomly divided into traditional resistance training (TRT) and resistance training with blood flow restriction (BFR). Both groups performed the same training program. The TRT group performed the movement with 70-75% 1RM and the BFR group performed the movement with 25-30% 1RM. The exercise protocol was 90 minutes of training consisting of 10×3 with one minute of active recovery between sets. The program was implemented for 8 weeks. There was a significant difference ($P<0.001$) in CPK and LDH values in the two groups of Katsu training and resistance training.

Results: The results indicate that BFR training led to a significant reduction of LDH and CPK compared to the TRT group. BFR also caused less muscle damage compared to TRT ($P<0.001$).

Conclusion: The present study revealed that BFR causes less muscle damage and reduces releasing CPK and LDH. BFR can be a safer method to reduce muscle damage and cause less muscle damage compared to TRT training.

1. Introduction

One of the outcomes of exercise-induced muscle damage is the release of muscle-specific enzymes and proteins. (1) This leads to the release of creatine kinase (CK) into the bloodstream (2) which has been extensively monitored in sports medicine (3), In addition to the possible release of lactate dehydrogenase (LDH). (2) As a result, the development of safe and effective techniques for maintaining and improving muscle strength has long been a priority for researchers. (4) Some studies have shown that a low-intensity training program with vascular decreased pressure on the joints and ligaments causes less tissue damage while stimulating muscle strength. (4, 5) Such trainings are known as Kaatsu, in which the arterial blood flow and the active muscle blood flow are reduced (4). During Kaatsu training, the blood flow in the involved muscles in the exercise is restricted or completely blocked by strapping a flexible cuff to the proximal part of the thigh or arm. (6) The Kaatsu training intensity typically ranges between 20% and 30% of one repetition maximum (1RM), which is comparable to the level of intensity associated with everyday activity. Thus, individuals with differing physical characteristics can manage this style of training. (6, 7). In a study, Alvarez et al. have failed to identify significant changes in serum creatine kinase (CK) or lactate dehydrogenase (LDH) activity (i.e. indirect measurements of muscle damage) 24–48 hours after low load resistance training with BFR sessions on ten young

women (~20–30% 1RM)(8). Also, another research conducted on 12 male and 12 female elite rock climbers with at least 4 years' experience, determined that 4 weeks of training with and without blood flow restriction did not change the level of LDH and CPK (9). On the other hand, Sieljacks P et al. observed a significant change in the level of CK and LDH in seventeen healthy young men who performed blood-flow restricted resistance exercise training for 14 days. Yudai Takarada et al. observed a significant change in CPK in six young male athletes (10). As previous studies have been inconsistent, the scope of this study was to investigate the effect of resistance training with and without blood flow restriction on serum levels of LDH and CPK in beginner bodybuilders.

2. Methodology

2.1. Materials and methods

This quasi-experimental research consisted of two groups (traditional resistance training (TRT) and resistance training group with blood flow restriction (BFR)), which was done as a pre and post-test. During the first visit to the laboratory, anthropometric parameters and muscle strength (biceps with dumbbells (pair of hands), lats, leg curl, leg extension, machine hack squat, calf raise with a machine, leg press, squats with dumbbells, triceps with dumbbells (pair of hands), barbell shoulder press (front and back, Smith), biceps with the barbell, biceps sitting with the dumbbell, respectively) were evaluated. All two protocols were performed at the same time of the day, and the measurements were made before exercise (BE), immediately after exercise. Participants in the study were instructed to avoid caffeine, chocolate, nutritional supplements, and alcohol as well as to abstain from exercise for 4 weeks before, during, and 8 weeks after the study period. In addition, participants were instructed to sleep for a minimum of 6 hours the night before the training sessions. In the end, the participants were instructed to maintain the same eating habits during the study period and to not perform the Valsalva maneuver during the training sessions.

2.2. Participants

The samples were randomly divided into two equal groups: traditional resistance training (TRT) and resistance training group with blood flow restriction (BFR). Both groups performed exercise training three times a week for 8 weeks. The subjects were familiarized with the research before doing the exercise. The samples were 40 healthy volunteer male bodybuilders (age, 24±2 year) of the selective gym of Qazvin city, who had a maximum of three months of training experience in bodybuilding. The inclusion criteria were no smoking, use of androgenic and energizing supplements for at least three months and not to engage in other exercises during the research period. The exclusion criteria were the absence of more than two sessions in practice sessions and supplement consumption during the research period. After explaining all the research methods, potential risks, and possible benefits, each of the participants sign a written consent form before participating in this study. This study was conducted by the Ethics Committee of the Rasht branch, Islamic Azad University.

2.3. Measurements

Anthropometry measurement: Height and weight were measured in light clothing without shoes with an accuracy of 1 gram using a stadiometer (Seka, Germany). Body mass index (BMI) was estimated from the ratio of body weight in kilograms to the square of height (in meters). The body fat percentage was measured by the In Body device (720, South Korea).

One repetition maximum: For measuring one repetition maximum (1RM), bodybuilding machines and free weights (Mobarez, Iran) were used. The maximum amount of weight that the subjects could move up to eight to twelve repetitions was recorded. A maximum repetition test was calculated based on Berzyski's formula:

$$1RM = w \div [(1.0278) - (0.0278 \times r)]$$ *(W: weight r: repetition)*

Upper and lower body strength were measured by a dynamometer (SH5001, Seyhan, Korea). For measuring hand strength, samples hold the dynamometer in the hand being tested and squeeze the dynamometer with maximum isometric effort for at least 5 seconds.

Biochemical Analysis: CPK and LDH were determined using the Pars Azmoun kit (Tehran, Iran) by Hitachi autoanalyzer (Japan, 902). In this research, to investigate the effect of research interventions on the levels of biochemical indicators, laboratory measurements were carried out in two stages. The CPK and LDH were measured before and after the exercise intervention. Five ml of blood was taken from the brachial vein. The collected blood plasma was separated using a centrifuge (3000 rpm, 15 minutes), and all the blood samples were frozen at -20C.

2.4. Intervention

Traditional training: The first group performed traditional resistance exercises (70-75% of 1RM) 3 days per week for 90 minutes (ten min warm-up, and five minutes cool down) and each period of rest was one minute between sets and 2 minutes between movements with warming up for 10 minutes and cooling down for 5 minutes. Exercises for biceps with dumbbells (pair of hands), lats, leg curl, leg extension, machine hack squat, calf raise with a machine, leg press, squats with dumbbells, triceps with dumbbells (pair of hands), barbell shoulder press (front and back, Smith), biceps with the barbell, biceps sitting with the dumbbell. Each was in 3 sets of 10 repetitions. (11)

Blood flow restriction training: The program of the second group was similar to the first group (90 minutes, three times per week). The main exercises were performed with low intensity (25 to 30% of 1RM) 3 days a week, and a tourniquet was closed on the upper part of the body during the exercises. The desired pressure for the tourniquet was set to 100 mmHg(12), which according to research, this amount of pressure limits half of the blood flow. The program performed three sets, and the number of repetitions was done until exhaustion. The rest period between sets was one minute and the rest period between movements was two minutes. Training programs are presented in Table 1.

Table 1. *Exercise training program*

Training Program	Intensity	Duration	Warm Up	Cool Down
Traditional	70-75% 1RM	90 MIN	10 MIN	5 MIN
Kaattsu	20-30% 1RM	90 MIN	10 MIN	5 MIN

2.5. Statistical Methods

In this study, the Shapiro-Wilk test was used to examine the normal distribution of the data. A descriptive test was used to describe and explain the findings (table, average, and standard deviation). Analysis of covariance (ANCOVA) test was used to compare two groups, and a paired t-test was used to compare the pre-test and post-test for each training group. The analyses were conducted using SPSS version 26, and significance levels was less than 0.05 ($p<0.05$).

3. Results

All variables presented a normal distribution according to the Shapiro-Wilk test and the homogeneity of variances was checked using the Levine test, in the end, in the inferential part of the analysis of covariance and the correlation t-test for the analysis of the data in two parts, intergroup and intragroup. Table 2 shows the mean and standard deviation of variables.

Table 2. *Descriptive values within the research groups*

Variable	Groups	Pre-test Mean ± SD	Post-test Mean ± SD
Age (year)	Kaatsu	23.40±2.99	------
	Traditional	23.95±3.23	------
Height (Meter)	Kaatsu	1.74±0.06	------
	Traditional	1.78±0.094	------
Weight (kg)	Kaatsu	77.45±6.09	71.60±6.53
	Traditional	81.85±7.09	79.55±7.08
CK (U/L)	Kaatsu	80.25±16.67	66.50±15.52
	Traditional	81.60±17.16	80.15±14.68
LDH (U/L)	Kaatsu	261.50±18.39	227.35±17.32
	Traditional	226.75±20.17	253.7±21.37

The results of covariance analysis showed that there was a significant difference between the groups in CPK and LDH values. Also, to check the homogeneity of variances, Levine's test was used and it was seen that the assumption of homogeneity of variances was assumed for CPK and LDH was established. The results reported in Table 3.

Table 3. *Results of the covariance analysis test on CPK and LDH among the research groups*

variable	Time & Group	Sum of square	DF	Mean square	F	Sig
CK (U/L)	Pre-test	5687.66	1	2843.83	70.33	.061
	Group	1603.60	1	562.3	19.83	.001*
LDH (U/L)	Pre-test	8406.20	1	4203.1	52.02	.001*
	Group	4880.42	1	782.23	30.20	.001*

The results showed that there was a significant difference ($P<0.001$) between the CPK and LDH in the two groups of Katsu training and resistance training as a result of the intervention, which means that resistance training combined with BFR causes a significant decrease in CPK and LDH compared to traditional resistance training.

4. Discussion

Mechanical metabolic stress from intense physical activity leads to biological damage to the phospholipid membrane. However, high-intensity physical activity, unlike low-intensity activities, may put pressure on the body's immune system and, on the other hand, expose the body to mechanical overloads, which can stimulate the tissue to adapt to the overload. However, increasing the training load too much can cause muscle damage and damage to the connective tissue. Therefore, in recent years, resistance training with low intensities such as BFR can increase muscle size and strength and put less pressure on joints and ligaments and there will be less damage. Our findings showed a significant decrease in LDH and CPK in the BFR group compared to the moderate severity resistance training group. In research, Fekri Kourabbaslou et al. investigated the effect of AR (active rest) during resistance training with BFR in six weeks in twenty young men. The results showed that the LDH decreased in both groups (13). Another study that investigated the effect of Kaatsu included seated knee extension and flexion and leg press exercises with moderate blood flow restriction twice a week for 3 months on patients receiving cardiac open surgery and observed that CPK was at normal levels after 3 months of Kaatsu(14). Also, Sieljacks P et al. observed a reduction of CK in the BFR training group compared to traditional training on six young male athletes aged 20–22 years old(15). On the other hand, Vakili et al. observed that rock climbing training with or without BFR in 4 weeks, does not increase muscular damage (16). In contrast, Michael Behringer et al. observed that CPK levels increased after moderate intensity eccentric on male sports students (17). Furthermore, the CK level increased and the LDH level didn't change in 10 recreationally trained [1–5 years strength training] military males in Gabriel R. Neto et al. research (18). Another study didn't find any difference after 4 weeks of climbing with and without limitation of blood flow on LDH and CPK of elite rock climbers (16). This variation is conceivable because different methods are used. It has been suggested that a short-duration exercise with blood flow restriction may contribute to an inadequate response to metabolic and mechanical stresses associated with exercise because serious and often invariable skeletal muscle damage usually occurs after prolonged exposure to ischemia. The lack of a significant change in muscle damage markers can also be attributed to the time of sampling after the last exercise session. Over the next few minutes and during the inflammation period, the number of circulating neutrophils increases with the occurrence of damage. Following tissue damage, macrophages begin to accumulate in the affected area and actively release histamine within 6 to 12 hours after initial injury. The increase in local temperature and the activation of pain receptors in muscles and tendons accumulate histamine, potassium, and quinine, through phagocytosis and cell necrosis. All of these elements can result in the increased release of creatine kinase (CK), lactate dehydrogenase (LDH), and aspartate aminotransferase, alongside distress and muscle soreness (19). Also, BFR training probably has less effect on inflammatory and anti-inflammatory systems. In this regard, Mirjafari, and shabani showed blood flow restriction training didn't have any effect on the salivary cortisol of female

bodybuilders, but in moderate intensity resistance training, a significant increase in salivary cortisol was observed (20). Some researchers believe that muscle cramp caused by muscle damage, reaches their peak 24-72 hours after training (21). Thus, it is recommended to collect blood samples for longer periods after the last training session. The present study has some limitations that need to be emphasized. Firstly, the sample size was small. Hence, more research with larger sample sizes needs to be done to verify these results to generalize to other athletes. Another limitation was absence of an evaluation of pain, range of motion and reduced muscle strength that could help further explain the results.

5. Conclusion

The results of the present study showed that resistance training for eight weeks and three days a week, along with restricted blood flow reduced muscle damage and muscle damage in young beginner bodybuilders. Therefore, this method can be used as an effective and alternative method to reduce injury symptoms help health indicators, and increase strength. It is recommended to use Kaatsu training instead of traditional training due to less pressure on the joints and reduction of muscle damage in bodybuilding courses. Also, it is suggested that research with a longer period and with more sessions with resistance exercises and blood flow limitation on the dependent variables of the current research being conducted and compared among professional and beginner male bodybuilders. It is required to research resistance exercises and blood flow restriction on the dependent variables of the current research among athletes of different sports fields.

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Conflict of interests: The authors declare that they have no conflict of interest relating to the publication of this manuscript.

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