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Comparison of the Effect of Consuming Carbohydrate or Protein during Exercise on Hormonal Response

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Abstract

***Background*:** The study tries to compare the effect of carbohydrate and protein supplements intake during exercising on the hormonal response to a resistance exercise session.

***Materials and Methods*:** The subjects of the study were 20 young men who divided into two 10-member groups. During a resistance exercise session, they received drinks containing carbohydrate (CHO group) and or protein (PRO group). The blood samples were collected before and after exercise and their cortisol and insulin contents were measured.

***Results*:** The results showed that while PRO group experienced a 17.23-unit increase in its cortisol content, it was only 0.71 units in the CHO group. Insulin response in CHO group (8.12) was significantly more than that in PRO group (4.69) (p=0.01).

***Conclusion*:** The results indicate that compared to protein supplements, using carbohydrate supplements during exercising enables the human body to achieve a better hormonal environment after the exercise.

Introduction

Resistance exercises stimulate short-term changes in repairing muscles protein content which will lead to increasing protein breakdown and synthesis [1- 3]; however, the net protein balance of muscles (the difference between synthesis and breakdown of muscles' protein) is till negative during early recovery period after resistance exercises [1]. Likewise, even 48 hours after a resistance exercise round, protein breakdown maintains its high rate [4]. Physiological pressures caused by various protocols of resistance exercises, which are carried out in order to maximize their stimulation across the main muscular groups, increase the cortisol level to more than 500 nmol/l [4-6]. Carbohydrate intake just before exercising increases the blood sugar volume of body and blocks the cortisol response [7]. Moreover, the increased blood sugar which is seen after intake of carbohydrates will result in increased blood's insulin concentration which is a completely anabolic hormone. When such an environment is developed, further potential is provided to enhance protein content and musculoskeletal growth [1].

On the other hand, recent studies suggest that if the necessary amino acids are not consumed by the human body, the net protein balance will remain negative even after resistance exercise. Accordingly, in spite of the increased blood cortisol content after a resistance exercise for more than 90 minutes, intake of necessary amino acids can stimulate muscular protein synthesis and also can maintain net protein balance [3]. There are many other studies which verify these results through intake of carbohydrate supplement intake after a resistance exercise [5, 9]. Authors have interpreted the reasons of such results differently; while the increased concentration of the extracellular amino acids after intake of 15 gr. necessary amino acids subsequent to a resistance exercise always leads to the removing of extra amino acids and increasing of protein synthesis rate in the muscular cells, carbohydrate intake enhances blood sugar content, stimulates insulin, blocks cortisol infiltration and decreases protein breakdown [9]. Other anabolic hormones such as testosterone, growth hormone and Insulin-like growth factor-1 (IGF-1) are effective in developing positive net protein balance for muscles. However, there is no sufficient information about the interactive effect of nourishment and resistance exercise on these hormones [6, 10]. The best time to consume food supplements is another uncertainty of the discussion, but there are few studies on consumption of the food supplements during resistance exercises [11].

Generally, the whole information about resistance exercise and consumption of the food supplements indicate that nutritional interventions such as protein and carbohydrate supplements can be used to bring about positive hormonal changes during resistance exercises and to improve net protein balance after exercise and eventually to increase effectiveness of the resistance exercises [6, 10]. Therefore, the question arises that which kind of supplements may stimulate better hormonal response after exercise which is necessary for developing a better environment for anabolism and effectiveness of

the resistance exercises? Hence, our study started to analyze and compare the effect of consumption of carbohydrate and protein supplements during exercise on the hormonal response caused by a severe resistance exercise round.

Materials and Methods

The study was conducted according to quasi-experimental and practical research principles. The statistic population of the study included 18-25-year-old university students who selected physical training course and had no experience in working with halters. A number of 20 students (average age: 22.34±2.54 years, weight: 76.9±5.6 kg, and height: 177.1±4.48 cm) as available sample were divided randomly in two 10-member groups: 1) the group who consumed carbohydrate supplements during their resistance exercise (called CHO) and the group who consumed protein supplements during their resistance exercise (called PRO).

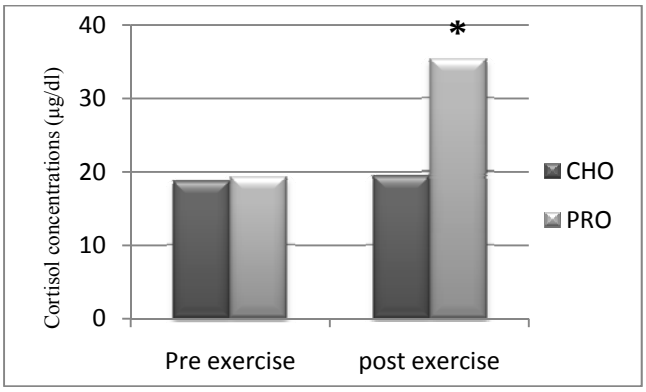
Three days before starting the resistance exercise, our subjects participated in the one-repetition maximum (1-RM) test. After three days, our subjects participated in a resistance exercise session including six selected exercises: bench press, biceps curl with barbell, side stretch, leg press, knee stretch, knee bending while they had not eaten anything since four hours before exercising. The mentioned exercise with 75% of One-Rep Max was repeated three times, each time was associated with 8-12 8-12 rep max. Depending on their group, each subject received 10 ml/kg drink containing 6% glucose (CHO group) or 0.2 g/kg protein (PRO group) during their exercises for 7 times. Blood samples before and immediately after exercise were collected by the lab experts and were sent to the lab in order to measure insulin, cortisol, growth hormone and total testosterone and IGF-1 concentration. Hormones concentration was analyzed using ELISA technique. The descriptive statistics and inferential statistics were used to explain data and to test research hypotheses, respectively. The independent *t* was employed to compare the difference between the two groups and to examine equity and variances, Leven's test was used. All statistical works of the study were facilitated with SPSS-11 and the significance level for tests was set at $p< 0.05$.

Results

Table 1 shows the information about the hormonal changes in CHO and PRO groups before and after resistance exercise. The concentrations of cortisol and insulin before and after resistance exercise have been compared in figure 1. The results of the independent *t*-test indicated that the cortisol hormonal changes after resistance exercise was higher in PRO group than CHO group (p=0.0005). Likewise, the hormonal changes of insulin after resistance exercise was higher in CHO group than PRO group (p=0.01). For growth hormone, total testosterone and IGF-1 no significant differences were gained.

Table 1. Comparison of effect of consumption of carbohydrate along with placebo during exercising on concentration of cortisol, insulin, growth hormone and IGF-1

Hormone	Groups	Hormonal changes Mean±SD	Mean Difference	*p*-Value
Cortisol (µg/dl)	CHO PRO	20.67±7.1 4.59±17.2	1.75 ±16.51-	0.0005
Insulin (µIU/ml)	CHO PRO	3.01±8.12 2.08±4.69	1.17 ±3.43	0.01
GH (µIU/ml)	CHO PRO	5.87±18.55 7.23±25.33	3.18±6.50-	0.057
Total testosterone (µg/dl)	CHO PRO	1.45±2.30 3.13±1.57	1.14±0.73	0.52
IGF-1 (µg/dl)	CHO PRO	55.68±72.77 92.93 ±48.90	35.68±23.87	0.51



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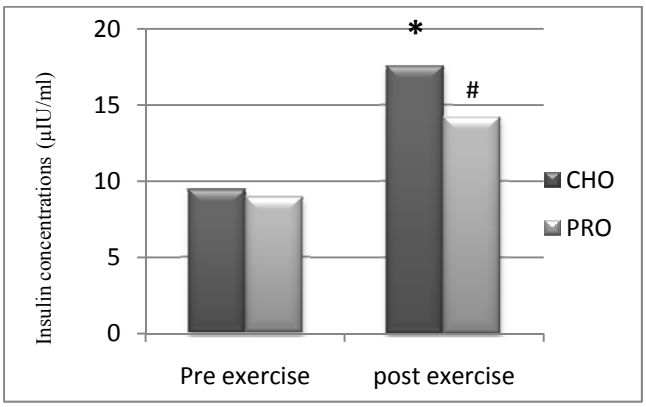

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Figure 1. Changes of concentrations of cortisol (A) and Insulin (B) before and after resistance exercise

Discussion

Our results indicated that intake of the carbohydrate supplements during resistance exercise inhibits increasing of the cortisol concentration at the end of exercising, while the PRO group experienced a significant increase in cortisol concentration. The finding is consistent with the results reported by Bird et al. and Chandler et al [4, 7]. The increased cortisol concentration at the end of the resistance exercise is one of the most important factors involved in breakdown of the myofibril proteins [10].

Staron studied adaptations of skeletal muscles during early stages of a resistance exercise and he found that there were some positive changes in skeletal muscles size along with the decreasing of resting cortisol levels in the young men [6]. Similarly, a reverse significant relationship was reported the ratio between the muscular fibers (type II) cross sectional area (increase) to resting cortisol levels (decrease) [12].

Hence, the regulated cortisol response after exercise in CHO group, reduces tissues exposed to cortisol hence affect the following stages of recovery including either anabolic or catabolic processes [4, 5]. However, since the level of the removed amino acids, the myofibril proteins synthesis and the breakdown level of proteins had not been evaluated in this study, reaching a precise and detailed conclusion on the effect of the decreased cortisol levels on the net protein balance in both groups is somehow impossible, because eventually the decreased cortisol level in CHO group can affect the effectiveness of the resistance exercise which leads to the improved net protein balance during recovery after exercise. According to our study, there is a reverse relationship between the decreased cortisol level and the increased blood glucose level at the end of the resistance exercise which is consistent with the results of Bird et al [4].

Acceleration of Gluconeogenesis process is the first effect of increased cortisol infiltration; thus, the increased blood glucose level, the inhibition of adrenocortical stimulation and the decreased cortisol infiltration from these glands can be considered as the most important mechanisms involved in inhibiting cortisol infiltration in CHO group [4, 12].

Our results also showed that the insulin concentration after exercising in CHO group increased significantly very higher than that in PRO group. It is consistent with Bird et al [4, 6]. Further increase of the insulin concentration in CHO group compared to the PRO group can be related to the increased level of the blood glucose and its effect on pancreatic Beta cells. While any possible increase in concentration of the circulating amino acids of PRO group has less effect in increasing of the blood glucose concentration. Insulin affects significantly the protein metabolism [8]. Recent studies had shown that increased level of insulin enhances removal of amino acids and synthesis of proteins after the resistance exercise on the one hand and decreases the activity of proteolytic enzymes [13].

Accordingly, the key phenomenon which stimulates skeletal muscles hypertrophy is the increased transmission of the amino acids into the muscle which has a direct relation with the contractile activity of muscles and plasma's insulin concentration [4]. Hence, the increased level of insulin subsequent to a resistance exercise would be significant for improving the net protein balance and for increasing the effects of exercising. However, researches have shown very well that conducting a resistance exercise generally is associated with the decreased levels of insulin at the end of any resistance exercise. Therefore, using insulin stimulant supplements is a good strategy to strengthen insulin infiltration and to affect the anabolic and catabolic processes after the exercising. Although intake of carbohydrate increases the insulin concentration in plasma, it would not be along with the decreased muscular protein synthesis [2, 10], because it had been demonstrated that when the external necessary amino acids are insufficient, even when the insulin concentrating is high, the protein synthesis process is not compensated [1]. However, it is not the case for the decreased rate of myofibril proteins breakdown. Probably, the increased level of insulin after exercise in CHO group declines the breakdown rate of such kinds of proteins [2, 3, 13].

Generally, it can be concluded that although consumption of the six-percent carbohydrate supplement in contrast to intake of protein supplement during the preliminary exercise can bring about a better hormonal state through improving hormonal changes, particularly through increasing insulin levels and decreasing cortisol levels after exercising, some further studies are needed to reach a detail conclusion about the general anabolic condition resulted from consumption of carbohydrate and protein supplements; because the resulted hormonal state after a resistance exercise is only a part of human body anabolic environment and other variables such as levels of circulating amino acids, synthesis and breakdown rate of proteins (net protein balance) and the activation level of anabolic and catabolic enzymes are effective to form the environment as well.

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Authors' Contributions

All authors had equal role in design, work, statistical analysis and manuscript writing.

Conflict of Interest

The authors declare no conflict of interest.

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