Journal of Physical Activity and Hormones

Vol **3**, No. **3**, Ser. **11** (September **2019**), **013-022**

Comparison the effect of short vs. long rest period between the sets in resistance training on testosterone to cortisol ratio

Tanaz Abbasi[1] and Mehrzad Moghadasi[2]*

Received: 22 July 2019 / Accepted: 29 August 2019

(1) MS in exercise physiology, Department of Exercise physiology, Marvdasht branch, Islamic Azad University, Marvdasht, Iran.

(2)* Associate professor in exercise physiology, Department of Exercise physiology, Shiraz branch, Islamic Azad University, Shiraz, Iran. E-mail: mehrzad.moghadasi@gmail.com

Abstract

Introduction: There is a little information about the effect of rest period length on hormonal adaptation. The purpose of this study was to investigate the effect of short *vs.* long rest period between the sets in resistance training on testosterone to cortisol ratio (Ts / Co ratio).

Material & Methods: Sixteen experienced, weight trained men volunteered to participate in the study. Subjects were randomly assigned to either a short (30 second; P30) or long (120 second; P120) rest period group. During the first 2 weeks of training, 3 sets of 10-12 repetition maximum (RM) with 120 second rest intervals between sets and exercises (hamstring with machine, squat, dead lift and leg press) were performed by both groups. During the next 6 weeks of training, the P120 group trained using 120 second between

sets and exercises (4 sets of 8-10RM), and the P30 group trained using 30 second between sets and exercises as the 6 weeks of training progressed (4 sets of 8-10RM). Blood samples were taken at baseline, immediately and 30 min after the last session of training for measurement serum Ts and Co concentrations.

Results: The results indicated that Ts/Co ratio had tendency to increase immediately after last session of resistance training in P30 and P120 group however no significant differences were observed between these groups. The Ts/Co ratio at post exercise was higher but not significance in the P120 in compare to the P30.

Conclusion: Our results suggested that there is no significant difference in Ts/Co ratio after short or long rest period between the sets in resistance training.

Keywords: Recovery time, Resistance training, Hypertrophy, Testosterone, Cortisol

1. Introduction

Resistance training has become one of the most popular physical activities for increasing characteristics such as absolute muscular strength, hypertrophy and muscular power. The acute training program variables including exercise order, rest periods between sets, exercises sessions, weekly frequency, speed of movement, training duration and volume, number of repetitions and sets, load, or intensity can all be manipulated to meet training goals and address individual differences in training needs and goals (1-4). For efficient, safe and effective training, it is of utmost importance to understand the interaction among training variables, which might include the intensity, number of sets, rest interval between sets, exercise modality and speed of muscle action. It appears that manipulation of these training variables can influence hormonal and biological responses to training and then training results (5,6).

The ratio between the concentration of testosterone and cortisol (Ts / Co ratio) is frequently used as an index of the stress level in exercise

training. Changes in this ratio are responsible for several training responses such as hypertrophy and strength gain (7,8). Furthermore, there is some evidence suggest that the Ts / Co ratio would be a physiological indicator of overtraining in heavy load exercise training, but it is not enough for prediction of overtraining syndromes (9,10). Previous studies have indicated that Ts and Co responses to resistance exercise are affected by several variables such as intensity, volume, duration, rest periods, and muscle mass involvement (11,12).

Researches have indicated that the rest interval between sets is an important variable that affects both acute responses and chronic adaptations to resistance exercise programs (13,14). However, response of Co and Ts to different rest interval is unclear. Rahimi et al. (2011) reported that the Ts / Co ratio at post exercise was significantly higher in 120 second (s) than 60 s and 90 s, but no difference was found between 60 s and 90 s (15). In another study Rahimi et al. (2010) has demonstrated that serum Ts concentrations were significantly higher in 120 and 90 s of rest interval between sets compared to 60 s in men (16). However, Buresh et al. (2009) showed that concentration of both Co and Ts with short rest interval (1 min) was more than long rest interval (2.5 min) after 1 week resistance training in untrained men (17). Ahtiainen et al. (2005) observed no significant differences in acute effect of short (2 min) and long (5 min) rest interval on concentrations of serum total Ts, free Ts, and Co (18). The purpose of this study was to compare the effect of short *vs.* long rest period between the sets in resistance training on Ts / Co ratio in weight trained men.

2. Material & Methods

Subjects

Sixteen men with at least 2 years of recreational resistance training experience participated as subjects in the study. All subjects answered the Physical Activity Readiness Questionnaire (PAR-Q), and signed an informed consent form before participation in the study according to the Declaration of Helsinki. Subjects were randomly assigned to either a short (30 second; P30, n=8) or long (120 second; P120, n=8) rest period group. The study was approved by the Islamic Azad University,

Marvdasht branch Ethics Committee. Subjects were on their ordinary diet, not permitted to use nutritional supplementation and did not consume anabolic steroids or any other anabolic agents known to increase performance.

Resistance training program

During the first 2 weeks of training, 3 sets of 10-12 repetition maximum (RM) with 120 s rest intervals between sets and exercises (hamstring muscle training with machine, squat, dead lift and leg press) were performed by both groups. During the next 6 weeks of training, the P120 group trained using 120 s between sets and exercises (4 sets of 8-10RM), and the P30 group trained using 30 s between sets and exercises as the 6 weeks of training progressed (4 sets of 8-10RM).

Measurements

One-Maximum Repetition Test

Maximal strength was assessed by using one repetition maximum (1RM) (19,20). Warm-up consisted of a set of five repetitions at the loads of 40-50% of the perceived maximum. An attempt was considered successful when the movement was completed through a full range of motion without deviating from proper technique and form.

Biochemical analyses

Blood samples were taken at baseline, immediately and 30 min after the last session of training for measurement serum Ts and Co concentrations. Blood samples (5 ml) were collected into tubes from the antecubital fossa using standard venipuncture techniques and serum obtained was frozen at –22 °C for subsequent analysis. Co and Ts concentrations were measured using an enzyme-linked immunosorbent assay (ELISA) kits (Monobind Inc; USA).

Statistical analysis

Results were expressed as the mean ± SD and Shapiro-Wilk Test was applied to evaluate the normal distribution of variables. Two-way analysis of variance with repeated measures (2×3) was used to compare

blood samples for the different programs, followed by a Bonferroni post hoc test where appropriate. Statistical evaluation was performed with SPSS 17.0 for windows and the significance level of the study was set at $P<0.05$.

3. Results

Ts and Co concentration and Ts / Co ratio at baseline and immediately and 30 min after the last session of training is presented in Table 1. The results indicated that Ts / Co ratio had tendency to increase immediately after last session of resistance training in P30 and P120 group however no significant differences were observed between these groups. The Ts / Co ratio at post exercise was higher but not significance in the P120 in compare to the P30.

Table 1. Changes of Ts and Co concentration and Ts / Co ratio during the study

Groups	Baseline	Immediately after	30 min after	P value
Testosterone (mg/dl)				
P30	0.48 ± 0.1	0.46 ± 0.1	0.34 ± 0.1*†	P = 0.001
P120	0.42 ± 0.1	0.40 ± 0.1	0.37 ± 0.1	
Cortisol (mg/dl)				
P30	17.9 ± 5.3	15.3 ± 5.0	13.5 ± 4.2	P = 0.13
P120	17.5 ± 7.2	13.5 ± 4.6	11.4 ± 2.4*	
Ts / Co ratio				
P30	0.02 ± 0.01	0.03 ± 0.01	0.02 ± 0.01	P = 0.21
P120	0.02 ± 0.009	0.03 ± 0.008	0.03 ± 0.007	

* Significant differences with baseline

† Significant differences between groups

4. Discussion

Resistance exercise is the most effective way for achieving acute increase in the concentration of anabolic hormones, which in turn stimulates strength and muscle hypertrophy (21,22). Resistance exercise has been shown to induce acute hormone responses, which are dependent on the type of exercise protocol, i.e., intensity (load) of exercise, number of sets and repetitions per set, length of rest periods between sets, and muscle mass involved (3,4).

The aim of present study was to investigate the effect of short *vs.* long rest period between the sets in resistance training on Ts / Co ratio. Therefore, experienced weight trained men have performed a resistance training protocol (4 sets of 8-10RM) with different rest intervals of 30 and 120 seconds between the sets. Our results indicated that Ts / Co ratio had tendency to increase immediately after last session of resistance training in P30 and P120 group however no significant differences were observed between these groups. The Ts / Co ratio at post exercise was higher but not significance in the P120 in compare to the P30. In line with our results, Ahtiainen et al. (2005) also reported that there were no significant differences in acute effect of short or long rest interval on concentrations of Ts and Co (18); while, Rahimi et al. (2010) and Rahimi et al. (2011) reported that the Ts / Co ratio and serum Ts concentrations were significantly higher in 120 second (s) than 60 s of rest interval between sets in men (15,16). Buresh et al. (2009) also showed that Co and Ts concentration with short rest interval was more than long rest interval after 1 week resistance training in untrained men (17). These discrepant results may be attributed to the subjects training status, exercise protocol and the subject populations.

Ts have been known as hormones involved in anabolic processes in muscle cells (16). Therefore, this hormone may instigate an increase of muscle mass. Our data revealed that the Ts / Co ratio at post exercise was higher in the P120 in compare to the P30 however it was no significant statistically. This is due to reduce of Co in P120 more that P30 and reduce of Ts in P30 more that P120 after the intervention. Co secretion responds quite rapidly to various stresses (e.g. exercise, hypoglycemia, surgery, etc.), typically within minutes (15). Bottaro et al. (2009) reported that Co concentrations were not different among three resistance exercise protocol with 30, 60 and 120 s rest durations between sets (23). On the other hand, Gotshalk et al. (1997) reported that three sets versus one set of resistance exercises resulted in a greater Co increase (24). They have demonstrated that shorter rest intervals are associated with an increased Co response after resistance training. The mechanisms responsible to decrease Co concentrations in our study may be due to hormonal and metabolic adaptation in response to 8 weeks resistance training.

5. Conclusion

The present study indicated that, within resistance training protocol used in the present study, the length of the recovery times between the sets (30 *vs.* 120 second) did not have an influence on Ts / Co ratio.

6. Acknowledgment

The authors wish to thanks all people whom cooperated in this study.

Conflict of interests: The authors have no conflicts of interest to declare.

References

1. American College of Sports Medicine position stand. Progression models in resistance training for healthy adults. Med Sci Sports Exerc 2009; 41: 687-708.
2. Pearson D, Feigenbaum A, Conley M, Kraemer WJ. The National Strength and Conditioning Association's basic guidelines for the resistance training of athletes. Strength Cond J 2000; 22: 14-27.
3. Simão R, Farinatti Pde T, Polito MD, Maior AS, Fleck SJ. Influence of exercise order on the number of repetitions performed and perceived exertion during resistance exercises. J Strength Cond Res 2005; 19: 152-156.
4. Miranda H, Fleck SJ, Simão R, Barreto AC, Dantas EH, Novaes J. Effect of two different rest period lengths on the number of repetitions performed during resistance training. J Strength Cond Res 2007; 21: 1032-1036.
5. Spiering BA, Kraemer WJ, Anderson JM, Armstrong LE, Nindl BC, Volek JS, et al. Resistance exercise biology, manipulation of resistance exercise program variables determines the responses of cellular and molecular signaling pathways. Sports Med 2008; 38: 527-540.
6. Viru A, Viru M. Assessing changes in adaptivity for optimizing training strategies. In: Viru A, Viru M, editors. Biochemical monitoring of sport training. Champaign: Human Kinetics; 2001.
7. Uchida MC, Bacurau RFP, Navarro F, Pontes Jr FL, Tessuti VD, Moreau RL, et al. Alteration of testosterone: cortisol ratio induced by

resistance training in women. Rev Bras Med Esporte 2004; 10: 169-172.

8. Volek JS, Kraemer WJ, Bush JA, Incledon T, Boetes M. Testosterone and cortisol in relationship to dietary nutrients and resistance exercise. J Appl Physiol 1997; 82: 49-54.
9. Keizer HA. Neuroendocrine aspects of overtraining. In: Kreider RB, Fry AC, O'Toole ML, editors. Overtraining in sport. Champaign: Human Kinetics; 1998.
10. Urhausen A, Gabriel H, Kinderman W. Blood hormones as markers of training stress and overtraining. Sports Med 1995; 20: 351-376.
11. Fry AC, Kraemer WJ, Stone MH, Warren BJ, Fleck SJ, Kearney JT, et al. Endocrine responses to overreaching before and after 1 year of weightlifting. Can J Appl Physiol 1994; 19: 400-410.
12. Kraemer WJ. Endocrine responses to resistance exercise. Med Sci Sports Exer 1988; 20: S152-S157.
13. de Salles BF, Simão R, Miranda F, Novaes Jda S, Lemos A, Willardson JM. Rest interval between sets in strength training. Sports Med 2009; 39: 765-777.
14. Gentil P, Bottaro M, Oliveira E, Veloso J, Amorim N, Saiuri A, et al. Chronic effects of different between-set rest durations on muscle strength in nonresistance trained young men. J Strength Cond Res 2010; 24: 37-42.
15. Rahimi R, Rohani H, Ebrahimi M. Effects of very short rest periods on testosterone to cortisol ratio during heavy resistance exercise in men. Apunts Med Esport 2011; 46: 145-149.
16. Rahimi R, Qaderi M, Faraji H, Boroujerdi SS. Effects of very short rest periods on hormonal responses to resistance exercise in men. J Strength Cond Res 2010; 24: 1851-1859.
17. Buresh R, Berg K, French J. The effect of resistive exercise rest interval on hormonal response, strength, and hypertrophy with training. J Strength Cond Res 2009; 23: 62-71.
18. Ahtiainen JP, Pakarinen A, Alen M, Kraemer WJ, Häkkinen K. Short vs. long rest period between the sets in hypertrophic resistance

training: influence on muscle strength, size, and hormonal adaptations in trained men. J Strength Cond Res 2005; 19: 572-582.

19. Kraemer WJ, Häkkinen K, Newton RU, Nindl BC, Volek JS, McCormick M, et al. Effects of heavy-resistance training on hormonal response patterns in younger versus older men. J Appl Physiol 1999; 87: 982-992.
20. Ahmadizad S, El-Sayed MS. The effects of graded resistance exercise on platelet aggregation and activation. Med Sci Sports Exerc 2003; 35: 1026-1033.
21. Boroujerdi SS, Rahimi R. Acute GH and IGF-I responses to short vs. long rest period between sets during forced repetitions resistance training system. South African J Res Sport, Phy Ed Rec 2008; 30: 31-38.
22. Spiering BA, KraemerWJ, Anderson JM, Armstrong LE, Nindl BC, Volek JS, et al. Resistance exercise biology, manipulation of resistance exercise program variables determines the responses of cellular and molecular signaling pathways. Sports Med 208; 38: 527-540.
23. Bottaro M, Martins B, Gentil P, Wagner D. Effects of rest duration between sets of resistance training on acute hormonal responses in trained women. J Sci Med Sport 2009; 12: 73-78.
24. Gotshalk LA, Loebel CC, Nindl BC, Putukian M, Sebastianelli WJ, Newton RU, et al. Hormonal responses of multiset versus single-set heavy resistance exercise protocols. Canadian J Appl Physiol 1997; 22: 244-255.