Science & Sports (2015) 30, 105—109

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BRIEF NOTE

Effects of short term creatine supplementation and resistance exercises on resting hormonal and cardiovascular responses

Effets d'une supplémentation de courte durée en créatine, et d'exercices de musculation, sur différentes hormones circulantes et le profil tensionnel

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Received 10 September 2012; accepted 25 March 2014
Available online 4 February 2015

KEYWORDS
Blood pressure;
Cortisol;
Creatine loading;
Heart rate;
Testosterone

Summary
Introduction. — The purpose of this study was to examine the effects of 3, 5 and 7 days of creatine loading coupled with resistance exercise on resting testosterone and cortisol concentrations, systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), heart rate and rate pressure product (RPP). These measures were compared to those in placebo group.
Summary of facts. — Twenty active males were randomly assigned to either a creatine group (Cr) or placebo group (Pl). Participants performed resistance exercises at day 3, 5, and 7; and also tested at day 4, 6, and 8. Subjects of the Cr group showed significant increases in testosterone concentrations and decreases in cortisol concentrations, in comparison with Pl and baseline, after 5 and 7 days of Cr loading ($P < 0.05$). There were no significant changes in heart rate, SBP, DBP, MAP, and RPP for both groups at all times ($P > 0.05$).
Conclusion. — Results of the present study suggest that more than 5 days of creatine supplementation, associated with resistance exercises is sufficient for increasing testosterone concentrations and decrement in cortisol concentrations.

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http://dx.doi.org/10.1016/j.scispo.2014.03.006
0765-1597/

MOTS CLÉS
Pression artérielle ;
Cortisol ;
Testostérone ;
Supplémentation en créatine ;
Fréquence cardiaque

Résumé
Introduction. — Le but de cette étude était d'évaluer les effets de 3, 5 et 7 jours de prise de monohydrate de créatine, associée à la réalisation d'exercices de musculation, sur les concentrations plasmatiques de testostérone, cortisol, les pressions artérielles systolique, diastolique, et moyenne, et le « double produit » (produit de la pression artérielle systolique par la fréquence cardiaque).
Résultats. — Vingt sujets régulièrement actifs ont participé à cette expérimentation, répartis en un groupe supplémenté en créatine (Cr), et un autre consommant un placébo (Pl). Les sujets ont suivi des séances de musculation à j3, j5 et j7, et ils ont été testés à j4, j6 et j8. Les sujets du groupe Cr ont présenté une augmentation significative de la concentration plasmatique de testostérone et une baisse significative de la concentration de cortisol, comparativement aux valeurs retrouvées chez les sujets du groupe, après 5 et 7 jours de supplémentation ($P < 0,05$). Aucune variation sensible et significative des valeurs tensionnelles n'a été détectée dans les 2 groupes expérimentaux ($P > 0,05$).
Conclusion. — Les résultats obtenus suggèrent que 5 jours de supplémentation, associés à la pratique de séances de musculation, permettent d'augmenter des concentrations plasmatiques de testostérone et de baisser celles de cortisol.

1. Introduction

Resistance exercise is known to be strong stimulus to change in the hormone secretion, blood pressure and heart rate. Resistance exercise stimulates the release of various anabolic and catabolic hormones, especially the testosterone and cortisol. The hormonal response to resistance exercise potentiates gains in muscle strength following training [1].

Previously reported that creatine (Cr) supplementation can be nutritional supplement for increasing strength, lean body mass and alters body composition [2]. The coordination between Cr supplementation and resistance exercise can be pivotal in enhancing hormonal response. It has been hypothesized that Cr induces hypertrophy through the endocrine mechanisms. To our knowledge, few studies investigated the effects of short term (e.g., 5 and 7 days) Cr supplementation on anabolic and catabolic hormones. For example, Volek et al. [3] compared testosterone and cortisol concentrations between Cr and placebo groups and found no Cr effect on endocrine status at immediately after-resistance exercise.

Exercise training has beneficial effects on cardiovascular system. Recently, attention has been given not only to the cardiovascular system benefits of regular physical training, but also to the effects resulting from acute exercise session. There were several data about the positive effects of resistance exercise in decreasing resting blood pressure [4]. Therefore, the purpose of this investigation was to examine the effects of 3, 5, and 7 days of Cr supplementation on resting testosterone and cortisol concentrations, systolic and diastolic blood pressure, heart rate, mean arterial pressure and rate pressure product in healthy human subjects.

Supplementation with Cr monohydrate can increase intramuscular phosphocreatine stores by about 25%, thus optimizing the resynthesis of adenosine triphosphate by the anaerobic alactic system. In addition, Cr supplementation leads to weight gain within the first few days, likely due to water retention related to Cr uptake in the muscle. Moreover, during specific exercise conditions, the Cr supplementation exhibit significant increases in physiological and performance changes [2]. To our knowledge, the influence of resistance exercise with Cr loading on resting blood pressure and heart rate are unclear and no study directly compared resting testosterone and cortisol concentrations following 3, 5 and 7 days of creatine loading.

2. Methods

2.1. Subjects

Twenty physical active males volunteered with informed consent to participate in this study, which had been approved by the ethic committee of the Center of Sport and Health Sciences at the University. Volunteers were free from musculoskeletal injury and had not taken any dietary supplement within the past 12 months. Volunteers were randomly assigned in a double-blind manner to a control or placebo group (Pl, $n = 10$; age 20 ± 1.1 y; weight 74.2 ± 4.8 kg; height 1.81 ± 0.07 m) and creatine investigation group (Cr, $n = 10$; age 21.5 ± 1.1 y; weight 74.6 ± 4.2 kg; height 1.78 ± 0.08 m). Volunteers 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.

2.2. Experimental design

One week prior to initiation of study, each participant was familiarized with the testing and resistance exercise procedures. Researchers clearly explained the purpose and procedures of the study to the participants who volunteered for the study. During this session, age (yr), height (m) and weight (kg) were determined. One week later, each participant was required to attend the laboratory on eight separate occasions, with the first visit for measurement of blood pressure and heart rate, testosterone and cortisol concentrations, respectively, and then six visits for completion of the main experimental conditions; 3 sessions resistance exercises (day 3, 5 and 7) and 3 sessions testing (day 4, 6 and 8). At the first visit, all participants given $4 \times 5\,g.d^{-1}$ dose of creatine or dextrose and maintained for seven days. All testing or exercise sessions began after approximately 12 hours overnight fast and 8 hours sleep. The temperature the laboratory was maintained at 21 °C.

2.3. Supplementation

During the seven days supplementation period, participants were prescribed a $4 \times 5\,g.d^{-1}$ dose of dextrose (placebo; Pl) or creatine (Cr) (Creatine Fuel, Twin Laboratories, Inc., Hauppauge, NY). Each supplement was measured using electronically calibrated scales and placed in identical coded airtight bags. Participants were instructed to consume the supplements, dissolved in approximately 300 mL of grape juice for better dissolution of creatine and ingested the solution with morning, mid-day, afternoon, and before sleep. Self-reported compliance to supplementation across the group was 100%. All participants were encouraged to adhere to their normal and similar dietary patterns throughout the study. Volunteers were also asked to maintain their normal level of daily activity during the investigation.

2.4. Resistance exercise prescription

Under the direction of professional fitness instructors, all resistance exercise sessions took placed in a weight training room. Participants performed resistance exercises at day 3, 5, and 7. During each session, subjects performed 3 × 10-rep of 9 exercises that included; bench press, shoulder press, lat-pull down, arm curl, leg press, leg extension, leg curl, squat, and abdominal crunches. The intensity of program was determined at 75 or 85% of one repetition maximum. A minute break between sets of exercise was allowed for rest. The subjects were not allowed to increase the lifting load during exercises.

2.5. Blood pressure measurements

After a 5-min rest in the sitting position, blood pressure was measured three times during two different visits to the laboratory. On the occasion of each visit, blood pressure was measured by the same experienced observer using a standard mercury sphygmomanometer, taking the first and the fifth phases of Korotkoff sounds as systolic (SBP) and diastolic (DBP) values, respectively. Subjects were excluded if the average of the last two values obtained during each visit for SBP and DBP was greater than 139 and 89 mmHg, respectively 18. Mean arterial pressure (MAP) was calculated DBP + [0.333 (SBP—DBP)], as it is mean pressure on arterial septum during cross a blood. The rate pressure product (RPP) was calculated SBP × heart rate, as it is considered a reliable predictor of myocardial oxygen demand. The heart rate (HR) response to exercise encompasses an integration of the cardiovascular, muscular, and central nervous systems. The HR was measured using Polar S610i heart rate monitor (beats per minute [bpm]).

2.6. Blood collection and analyses

Blood samples were obtained via venipuncture, after five minutes in a supine position, from an antecubital vein by using a 20-guage needle and vacutainer tubes for the determination of serum testosterone and cortisol concentrations. Blood samples were obtained in the early morning, and after a 12 hour overnight fast and occurred during a standardized time of day for each subject in order to minimize the effects of diurnal hormonal variations. The blood was processed and centrifuged, and the resultant serum was stored at −80 °C until analyzed. Total serum testosterone and cortisol were determined in duplicate by using standard radioimmunoassay procedures and were assayed via kits (Yellow Spring, OH). Coefficients of variations for variables (CV) for all the variables were less than 6%.

2.7. Statistical analyses

Data are presented in the text as mean ± standard deviation. Statistical evaluation of the data was accomplished by two-way repeated measures Anova. In the event of a significant F ratio, *Tukey* post hoc tests were used for pairwise comparisons. A criterion α level of $P < 0.05$ was used to determine statistical significance. All analyses were conducted using SPSS version 16.0 (SPSS Inc., Chicago, IL, USA).

3. Results

Significant changes were observed in resting testosterone and cortisol concentrations from baseline to 5 and 7 days supplementation in Cr group ($P < 0.05$). In addition, Cr group had significant higher resting testosterone concentration compared to Pl group after 5 and 7 days of creatine loading ($P < 0.05$). There were no significant differences between Cr and Pl, and among 3, 5, and 7 days of creatine loading for measures of resting SBP, DBP, MAP, HR, and RPP ($P > 0.05$). The Cr group made minimal differences in DBP, MAP, HR, and RPP, but these changes were not statistically significant ($P > 0.05$) (Table 1).

4. Discussion

The main result of the current study indicate that 5 and 7 days of Cr loading can increase resting testosterone concentration and decrease cortisol concentration, whereas no significant differences were observed between day 5 and 7. Previous researchers addressed elevating in resting testosterone concentrations following resistance training or exercise [1]. A significant elevation in resting testosterone was observed in young men and free testosterone has been shown to be elevated by 25% in young women who follow acute resistance exercise [1]. The increase of testosterone secretion and decrease of cortisol secretion according to results of current investigation are not in agreement with previous authors who examined effects of Cr supplementation on hormonal responses. Volek et al. [3] found no significant alteration in endocrine status after Cr supplementation to resistance exercise. The reason of this discrepancy could be differing in blood sampling.

Table 1 Resting hormonal and cardiovascular changes following 7 days creatine loading and resistance exercise. Values are mean ± SD.

	Cr				Pl			
	Baseline	Day 4	Day 6	Day 8	Baseline	Day 4	Day 6	Day 8
TEST[a]	4.04 ± 0.4	4.3 ± 0.4	4.6 ± 0.4[*,†]	4.6 ± 0.3[*,†]	4.01 ± 0.6	4.02 ± 0.5	3.9 ± 0.5	3.9 ± 0.5
COR[a]	14.3 ± 2.2	13.6 ± 2.1	13.1 ± 2.1[*,†]	13.02 ± 2.1[*,†]	14.6 ± 1.6	15.2 ± 1.5	15.1 ± 1.5	15.2 ± 1.3
SBP[b]	123.6 ± 6.7	123.2 ± 4.5	122.7 ± 4.2	122.5 ± 4.2	123.7 ± 5	123.5 ± 3.3	123.6 ± 2.6	123.4 ± 3.5
MAP[b]	94.8 ± 2.4	94.3 ± 1.9	93.7 ± 1.8	92.8 ± 3.6	95.8 ± 2.5	95.4 ± 2.3	95.5 ± 2.4	95.1 ± 2
DBP[b]	80.5 ± 4.1	80 ± 2.9	79.4 ± 3.1	78.1 ± 5.1	82 ± 3.6	81.5 ± 3.6	81.6 ± 2.9	81.9 ± 3.7
HR[c]	74.2 ± 6.8	70.9 ± 4.7	68.6 ± 4.1	69.4 ± 4	74.2 ± 6.6	73.8 ± 4.4	69.8 ± 2.3	70.1 ± 3.7
RPP[d]	9172.1 ± 891.1	8730.7 ± 601.5	8417.3 ± 575.3	8500 ± 567.1	9189.4 ± 1031.4	9116.2 ± 633.9	8628.8 ± 389.7	8649.1 ± 496.2

TEST: testosterone; COR: cortisol; SBP: systolic blood pressure; MAP: mean arterial pressure; DBP: diastolic blood pressure; HR: heart rate; RPP: rate pressure product.

[a] ng/mL.

[b] mmHg.

[c] Beat per minute (bpm).

[d] HR × SBP.

[*] $P < 0.05$, significantly different from the corresponding baseline.

[†] $P < 0.05$, significantly different from the corresponding Pl group.

Previous authors performed blood sampling immediately after resistance exercise, whereas we used a day after resistance exercise. Perhaps the effects of Cr loading with resistance exercise were shown several hours after exercise, however; further studies are necessary to explore these results. Enhancing testosterone concentrations in the Cr group suggest that resistance exercise combined with Cr supplementation provides a superior anabolic milieu. Also in cortisol concentrations, the Cr group exhibit decreases in secretion of cortisol. Indeed, the Cr ingestion can prevent from increasing cortisol concentration and enhance testosterone level. Therefore, Cr supplementation for 5 or 7 days is sufficient for increasing testosterone and decreasing cortisol secretion. These changes appear to result in greater increases in anabolic hormone and decreases in catabolic hormone to this supplementation.

No statistically significant differences were observed between Cr and Pl groups at 3, 5, and 7 days of Cr loading in SBP, DBP, MAP, HR, and RPP. Of course, in the present study we found little changes in blood pressure (BP). Studies have examined the acute effects of resistance exercise on BP. A statistically significant decrease in DBP was observed for up to 1 h after the session whereas no statistically significant reductions were found for resting SBP and also oscillatory pattern of SBP were observed for over 12 h post-exercise [5]. It is generally accepted that the mechanisms underlying the sustained decrease in blood pressure after training are a decrease in the resting heart rate and a decrease in circulating catecholamines [4]. This decrease in circulating catecholamines is directly related to a decrease in sympathetic nerve activity. Since Cr supplementation increases water content; the combination of water content and decreases post-exercise hypotension could not significantly changes in BP.

Mean arterial pressure (MAP) is a functional product of cardiac output and total peripheral resistance and affected by SBP and DBP. In this study, we found no significant changes in MAP, because the changes in SBP and DBP were not statistically significant.

In the heart rate (HR), the forces and intensity of resistance exercise, greater involvement of the fast-twitch muscle fibers and size of activated muscle mass may also stimulate increases in HR. In this study we did not find increases in HR. It appears that, Cr supplementation may be affected by these components and, consequently, the heart rate reduced.

Rate pressure product (RPP) is regarded as an important non-invasive means of estimating myocardial oxygen demand. A significant increase in RPP is produced during moderate to heavy resistance exercise in response to coupled increases in HR and SBP [4].

Previous studies reported increases in RPP induce by resistance exercise [4,5], but the present study demonstrated that an acute bout of resistance exercise with Cr supplementation may cause minor decrease in the post-exercise RPP below baseline levels. The minor changes can be affected by Cr supplementation at decreases in HR and SBP, and therefore the combination of Cr supplementation and resistance exercise may reduce risks factors after exercise.

Overall, it is important to emphasize that the current study has specifically addressed the effects of short term creatine supplementation on resting hormonal responses. However, it has been well established that creatine supplementation can enhance the ability to perform resistance training workouts [1]. This ''ergogenic'' action of creatine intake conceivably may enhance the hormonal responses to resistance exercise and thereby facilitate the resulting physiological adaptations. Also, the effects of this supplementation on blood pressure and heart rate needed more studies, because the data about this area is very little.

5. Conclusion

In conclusion, the data suggest that short term Cr supplementation (5 and 7 days) increases resting serum testosterone and decreases serum cortisol concentrations; also a systemic change in these hormonal alterations is supported. The present results demonstrated minimal decrease in resting BP after acute resistance exercise. Finally, we recommend that 5-day Cr supplementation can be prescribed to individuals for enhancing anabolic hormone and decreasing catabolic hormone.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

Acknowledgements

We gratefully acknowledge the volunteers involved in this study. We also thank our laboratory team for technical assistance with the immunoassay procedures.

References

[1] Kraemer WJ, Ratamess NA. Hormonal responses and adaptations to resistance exercise and training. Sports Med 2005;35:339—61.
[2] American College of Sports Medicine. Roundtable on the physiological and health effects of oral creatine supplementation. Med Sci Sports Exerc 2000;32:706—17.
[3] Volek JS, Boetes M, Bush JA. Response of testosterone and cortisol concentrations to high-intensity resistance exercise following creatine supplementation. J Strength Cond Res 1997;11:182—7.
[4] Mayo JJ, Kravitz L. A review of the acute cardiovascular responses to resistance exercise of healthy young and older adults. J Strength Cond Res 1999;13:90—6.
[5] Pescatello LS, Fargo AE, Leach CN, Scherzer HH. Short-term effect of dynamic exercise on arterial blood pressure. Circulation 1991;83:1557—61.