

The acute effects of weighted pull-ups on campus board power and power endurance exercises

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Abstract

Complex training means sequencing high resistance and power or speed exercises, which should be biomechanically similar to each other. The acute effect on pre-loading on subsequent power exercise is enhanced power output due to phenomenon known as post-activation potentiation. The phenomenon was usually tested in exercises and activities engaging lower limbs, like jumping or sprinting. The aim of our study was to investigate the acute effect of loaded pull-ups on performance on two campus board exercises: power and power endurance. Twelve climbers (8a to 8c RP) participated in the study. They performed two campus board exercises a/ power exercise: maximal reach from a deadhang position or b/ power endurance exercise: touches to the rung just below climbers' maximal reach, then coming back down to the bottom rung, and performing the same exercise with the second hand with repeating this cycle as many times as possible in the 20 s period. Both exercises were performed in conditions without preloading and after 5 RM pull-up on hangboard. The difference between both conditions was significant for power exercise ($t_{(df=11)} = -2.64$, $p=0.023$, Hedge's $g=-0.29$), and in the case of power endurance exercise a trend toward significance was observed ($t_{(df=11)} = -1.95$, $p=0.078$, Hedges' $g=-0.34$).

Keywords: complex training, campus board

Résumé

Les effets à court terme de l'utilisation de la formation combinée sur la puissance et l'endurance de puissance (power endurance) chez les grimpeurs de sport.

L'essence de la formation combinée consiste en exécution séquentielle des exercices explosifs et de résistance, qui devraient se caractériser par la similitude biomécanique. Ce concept est basé sur l'existence du phénomène de renforcement de la post-activation, grâce auquel la puissance, la force ou la vitesse générées obtiennent les valeurs supérieures que dans des conditions sans l'exécution précédente des exercices de résistance. Cette méthode crée le potentiel pour une utilisation dans la préparation de condition des grimpeurs sportifs, en particulier dans des disciplines telles que bouldering et escalade de vitesse où les capacités biomotoriques telles que la puissance, la force ou l'endurance de force sont des facteurs rassurant le succès dans le sport. Le but de l'étude était de déterminer s'il y avait une influence temporaire de l'exercice de résistance d'une haute intensité sur la puissance et l'endurance de puissance des membres supérieurs dans des exercices d'escalade réalisés au campus board.

Les participants de la recherche étaient douze grimpeurs du niveau d'escalade de 8a à 8c RP ayant de 6 à 30 ans d'expérience ($M = 12,0 \pm 6,3$ ans) et d'un an au minimum de la pratique sur le campus. La séquence des exercices combinés comprenait la hausse du corps avec les deux mains avec une charge de 5 RM sur la poutre et l'un des deux exercices au campus board: la portée maximale d'une hausse explosive réalisée avec le membre préféré (l'essai de la puissance) et la performance dans 20 secondes de plus grand nombre des portées à l'échelon juste au-dessous de la distance obtenue lorsque la portée maximale (l'essai de l'endurance de puissance). L'intervalle de temps entre l'exercice de résistance et les exercices sur le campus était de 4 minutes. La différence entre les conditions d'avant et d'après (PRE et POST) la charge était statistiquement significative dans le cas de l'essai de la puissance ($t_{(df=11)} = -2.64$, $p=0.023$, Hedge's $g=-0.29$), alors que dans l'essai de l'endurance de puissance nous avons observé une tendance vers la signification des différences ($t_{(df=11)} = -1.95$, $p=0.078$, Hedge's $g=-0.34$). Les résultats obtenus suggèrent l'existence d'un effet temporaire positif des exercices combinés sur les exercices du campus orientés vers le développement de la puissance des membres supérieurs.

Introduction

Complex training is defined as a mode of training in which resistance exercise is followed by biomechanically similar plyometric, power or speed exercise (Verkhoshansky & Siff, 1999). The physiological the above-mentioned effect is a complex phenomenon known as post-activation potentiation which results in a temporal increase in power and force production, thus allowing greater training stimuli and/or enhancing acute performance effect (Docherty & Hodgson 2007). Power and power endurance development are of crucial importance in preparation of sport climbers, especially boulders, but also extreme rock climbers. In all these activities movements like jumping from hold to hold or performing series of movements that require high power output are common. One of the most popular forms of climbing specific power training are campus board exercises (Michailov 2014). It would be worth investigating whether performing a heavy weight exercise before power campus board exercises would induce greater performance response of the latter. Therefore, the purpose of this study was to determine if there was a performance-enhancing response of power and power endurance exercises on the campus board that were performed after a high-load resistance exercise (weighted pull-ups).

Methods

After providing written informed consent, a total of 12 climbers voluntarily participated in the study. Sport climbing experience of the participants ranged from 6 to 30 years ($M=12$ years, $SD=6.3$), and their climbing performance level ranged from 8a to 8c RP. The test of 5 RM weighted pull-ups was performed on a Witchholds fingerboard using two 4 cm deep jugs. Power and power-endurance campus exercises were performed on 3 cm deep rungs. During the first testing condition, climbers were asked to hang on the lowest rung and perform three maximal reaches with their dominant arm, separated with 10 s rest periods. The distance was measured to the highest mark left by magnesium covering their fingers with accuracy of 0.5 cm. After 5 min rest, the second test was performed. It involved touches to the rung just below climbers' maximal reach, then coming back down to the bottom rung, and performing the same exercise with the second hand. The climbers were required to repeat this cycle as many times as possible in the 20 s period. After 10 min rest, climbers repeated both tests after preloading. The time interval between resistance exercise (weighted pull ups) and campus power or power endurance exercise was 4 minutes.

Statistical analyses

Assumptions of normality and homogeneity of variance were determined with the Shapiro–Wilk and Levene's tests, respectively. The resistance exercise-related effects on power and power endurance were analyzed using a Student's paired t -test. Effect size was calculated with the use of Hedges' g measure. All statistical analyses were conducted using Statistica 12.0 (Statsoft, PL).

Results

On average during the test of maximal reach after weighted pull-ups, climbers improved their performance by 3.11 cm (83.61 ± 10.94 vs 86.72 ± 9.40). The difference between PRE and POST loading was statistically significant and the size of the difference was weak-to-moderate: $t_{(df=11)} = -2.64$, $p=0.023$, Hedge's $g=-0.29$. Taking into consideration individual results eight climbers improved their results, one didn't changed and the remaining three got worse. The mean improvement were 6.87% (+1.52% to 10.75%), while the mean deterioration were -1.92% (-1.29% to -2.97%)

Mean number of “Touches” in the power endurance test was 14.0 ± 3.25 at baseline and 15.08 ± 2.94 after resistance exercise. The difference between both conditions reached only a tendency toward the difference: $t_{(df=11)} = -1.95$, $p = 0.078$, although the effect size suggests moderate strength of the relationship between both conditions: Hedges’ $g = -0.34$. Eight climbers improved, adding from 1 to 4 repeats, another two decreased their performance doing 1 and 3 less repeats than in no-preloading conditions and the remaining performed the same number of “Touches” in both conditions.

Discussion

The purpose of this survey was to assess acute effects of post-activation potentiation (PAP) in climbing-specific power and power endurance exercises on a campus board. The power exercise consisted of pulling up explosively from a dead hang position, and reaching with one’s preferred hand as high as climbers could touch. In the power endurance test, climbers performed similar movements, however at submaximal intensity and with the goal to complete as many reaches as possible in a 20 second time limit. Since proper exercise selection is of the utmost importance to induce PAP, we concluded that the criterion of biomechanical similarity was met by popular and most frequently performed resistance exercise consisting of pull-ups on a fingerboard with additional weight strapped to the climbing harness. The intensity of the pull-up was 5-RM which corresponded to ca. 85-87% of 1 RM (Baechle & Earle 2008) i.e. intensity within the range considered as most effective for producing PAP (Carter & Greenwood 2014). Our findings suggest that climbing specific resistance exercise performed before power exercise may significantly improve the latter. Mean value of the three maximal reaches interspersed with ten second rest intervals improved by 3.11 cm, while the best result of these three reaches improved by 2.25 cm. However, not all climbers responded in a similar manner. While most of them improved their results, some athletes remained at the same level and some even decreased their performance. This is consistent with previous findings in which dependence of performance results on training status was observed (Duthie, Young & Aitken, 2002; Docherty, Ribbins & Hodgson, 2004; Gourgoulis, Aggeloussis, Kasimati, Mavromatis & Garas, 2003). However, contrary to previous findings indicating that stronger individuals presented better PAP response, in our study improvements in power exercise were observed in weakest climbers. It may, however, be related to the nature of the exercise, as powerful climbers can reach so far from the starting rung that the pulling arm is fully flexed with the rung touching the edge of pectoralis major. In such condition, further movement could be possible with extending the arm in the elbow, which is extremely difficult (if possible) and, as a consequence, positive effect of the preload can hardly be expected. Considering inter-individual differences in response to a preload, one should also bear in mind that the potentiation window may be different for various athletes. Therefore, from a practical point of view, an optimal window of opportunity should be individually established for each athlete. In our study one time interval between the preload stimulus and the execution of a campus exercise was implemented. In such case for some climbers the interval might not be optimal.

In the power endurance test, eight climbers improved their performance, attaining from 1 to 3 reaches more after the preload. Two climbers decreased the performance and the remaining two presented no changes compared to baseline values. In this test, difference between two conditions reached only a trend toward significance, although the effect size was small-to-moderate. This may indicate that preloading could be also used to increase effectiveness of power endurance exercise. All in all, this problem is worth interest of sport climbing coaches

from one hand, and researchers from the other hand. The latter should consider studies with more participants and different time intervals.

Conclusions

Although our study is not without limitations, it is the first in which the effectiveness of PAP on climbing specific power and power endurance exercise has been demonstrated. It is also one of the first studies dealing directly with the problem of sport climbers' training. The results indicate positive effect of weighted pull-up exercise on subsequent power exercises on the campus board. It should be noted, however, that results of the preload on campus board exercise varied between individuals and more studies are needed in order to determine the most effective protocol of pairs of exercises in sport climbers' training.

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