

JOINT KINETIC CONTRIBUTIONS TO ACUTE PERFORMANCE ENHANCEMENT & DEGRADATION

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INTRODUCTION

Heavy resistance exercise generates acute physiologic responses that may enhance or degrade performance. Enhancement of performance is categorized as post-activation potentiation (PAP). Alternatively, degradation of performance is the consequence of fatigue responses.

Previous reports suggest PAP enhances muscle force generated under stimulated and voluntary conditions; however, the majority of this research has been performed utilizing single-joint isometric or isokinetic exercise modalities. Recent investigations have reported immediate improvement in performance on multi-joint tasks, such as vertical jumping, following heavy resistance exercise. These investigations, however, have only reported improvements in whole-body performance (Chiu et al. 2003). Recently, we reported that weightlifting exercise enhanced vertical jump performance by acutely increasing work performed by the knee extensors and ankle plantar-flexors (Chiu et al. In Press).

The purpose of this investigation was to determine the association between changes in net joint kinetics and PAP and fatigue during weightlifting exercise.

METHODS

Men (n=6) who were actively participating in heavy resistance exercise involving weightlifting exercises (snatch, clean & jerk)

were recruited for this investigation.

Participants attended 3 different resistance exercise sessions, approximately one week apart. All sessions involved the clean pull exercise, but were performed at different relative intensities. The order of sessions was randomized.

#1 – 75% 1 RM/5 repetitions * 12 sets

#2 – 85% 1 RM/3 repetitions *15 sets

#3 – 95% 1 RM/1 repetition *20 sets

During exercise, subjects wore a six-degree of freedom retro-reflective marker set on their lower extremity to capture kinematics of the feet, shanks, thighs and pelvis. Video data were captured by 8 optoelectronic cameras at 120Hz. All exercise was performed standing on a force platform sampling at 1560Hz. Standard 3D inverse dynamics procedures were applied to determine peak net joint moment (NJM) and net joint power (NJP) at the ankle, knee and hip in the sagittal plane. Retro-reflective tape was also placed on the center of the barbell and average power during the second pull (BP) was calculated (Garhammer 1993).

All data were normalized to the first set of exercise and expressed as a percentage of the first set performance. Thus, a value greater than 100% indicated a potentiation response; whereas, a value less than 100% indicated a fatigue response. The maximum (>100%; i.e. potentiation) and minimum (<100%; i.e. fatigue) % values were determined. Pearson product moment correlations were utilized to determine

associations between maximum/minimum changes in performance (BP) with maximum/minimum changes in NJM and NJP.

RESULTS AND DISCUSSION

For the 75% 1 RM condition, the BP potentiation response was correlated with maximum % for NJM ($r=0.96$; $p=0.01$) and NJP ($r=0.97$; $p<0.01$) of the knee extensors. Similarly, in the 85% 1 RM condition, BP potentiation response was correlated with maximum % for NJM ($r=0.95$; $p=0.02$) and NJP ($r=0.95$; $p=0.02$) of the knee extensors. In the 95% 1 RM condition, BP potentiation response was correlated to maximum % for NJM ($r=0.93$; $p<0.01$) of the hip extensors.

These results suggest different contributions to performance enhancement dependent on the relative intensity. For lower relative intensities (75% and 85% 1 RM), performance is enhanced by increasing knee extensor NJM and NJP. However, at the higher relative intensity (95% 1 RM), performance is enhanced by increasing hip extensor NJM. This difference suggests that training at lower relative intensities will result in different acute responses, than training at heavier relative intensities.

For the 75% 1 RM condition, the BP fatigue response was correlated with minimum % value for NJM ($r=0.92$; $p<0.01$) and NJP ($r=0.89$; $p=0.02$) of the knee extensors. No significant correlations were observed for BP fatigue response and net joint kinetics in the 85% and 95% conditions.

Similar to the potentiation responses, fatigue responses also appear to be dependent on the relative intensity. For the lowest relative intensity, fatigue manifests as a decrease in the NJM generated by the knee extensors. However, at heavier relative intensities, performance decrements are not associated

with decreases in NJM or NJP at the knee. It is possible that some participants fatigued their knee extensors and others fatigued their hip extensors, thus demonstrating no generalized relationship. Another explanation is that other factors, such as rate of force/torque development, time of maximum NJM/NJP, or muscle recruitment coordination are responsible for the fatigue demonstrated at higher relative intensities.

SUMMARY/CONCLUSIONS

Enhancement in performance during a high power multi-joint task is achieved by increasing peak NJM and/or NJP. The joint at which NJM/NJP is enhanced is dependent on relative intensity. Performance decrements at low relative intensities but not high relative intensities are the result of decreased NJM and NJP. The different potentiation and fatigue responses at the three relative intensities should be considered in the design of resistance training programs.

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