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The Effects of Post Activation Potentiation on Upper and Lower Extremities

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Can conditioning activities improve athletic performance?

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Abstract

Post activation potentiation (PAP) is a phenomenon where performance in power or speed movements increases after a performing high force conditioning exercise. The most common PAP observation is an increase in jump height after performing a weighted squat. In contrast, few studies have observed PAP in the upper body and it is unknown if upper and lower body muscles experience a similar PAP response. This has potential applications for athletes who use their upper body such as shot putters or boxers. In this study, we examined the effects of PAP in the lower extremity by seeing if a weighted squat can improve vertical jump (VJ) performance and in the upper extremities by seeing if a bench press can improve bench press throw (BT) performance. To test the research question, 9 strength trained (maximum squat > 1.5 time body weight and maximum bench press > 1.25 times body weight) participants took part in upper and lower body PAP testing in which they performed a power exercise (VJ or BT), a heavy conditioning exercise (weighted squat or bench press) and then repeated the power exercise. VJ and BT were performed on a force plate with ground reaction forces measured at 200 Hz and performance was assessed by calculating peak power output, peak velocity, and peak force from force plate data. The conditioning activities were 1 set of 3 reps at 85% of maximum load on both the bench press and squat lift respectively. A paired t-test was used to compare pre and post conditioning exercise performance in the VJ and BT. Results indicated a PAP in the BT as peak force significantly increased after the conditioning exercise (Δ 63.2 ± 48.7 N; p = 0.003). However, BT peak velocity (Δ -0.14 ± 0.33 m/s; p = 0.228) and BT peak power (Δ 147 ± 288 W; p = 0.141) did not significantly change. No PAP response was seen in the VJ where peak force non-significantly decreased after the conditioning exercise (Δ -49 ± 202 N; p = 0.438) and peak velocity (Δ −0.12 ± 0.27 m/s; p = 0.179) and peak power (Δ 261 ± 456 W; p = 0.141) non-significantly increased after the conditioning exercise. Contrary to previous works we did not observe a VJ-PAP response and in fact saw a non-significant decrease in performance in some variables. In contrast, we did observe a significant PAP response in the BT. PAP responses seem to differ on a case-by-case basis, possibly depending on muscle fiber distribution and history of training. Determining so called “responders” and “non-responders” within athletes will determine whether PAP could be used practically in upper and lower body movements.

Introduction

- Post activation potentiation (PAP) is a phenomenon where performance in power or speed movement increases after a high force conditioning exercise.
- While many studies have observed PAP, results of these studies are often varied as there is no consensus on the optimal load, repetition and recovery time of the conditioning exercise.
- The most commonly observed PAP effect is an increase in vertical jump height after performing a heavy squat (see Figure 1).
- While most experiments have examined lower body PAP [1,2] fewer have examined upper body PAP [3] and none have directly compare their effects.
- The degree of potentiation depends on training history, and fiber type of the individual and fiber type of specific muscles [4].

Figure 1. An example of lower body PAP.

- **Hypothesis:** We hypothesize that both upper and lower body will show similar, positive PAP responses.

Methods

For this study, 9 strength trained men (age: 21.8 ± 1.5 y, height: 1.81 ± 0.10 m, body mass: 89.3 ± 8.9 kg, maximum back squat: 153.7 ± 27.9 kg, and maximum bench press: 117.9 ± 19.9 kg) took part in upper and lower body PAP testing. Each participant performed 3 repetitions of a power exercise vertical jump (VJ) or bench throw (BT), a heavy conditioning activity (weighted squat or bench press), and then 3 more repetitions of the power exercise to determine if performance in the power exercise improved. For the conditioning activity (squat and bench press) each participant performed 1 set of 3 repetitions at 85% of the subjects’ maximum load. During the power exercises (VJ and BT) ground reaction forces were measured using a force platform, collecting data at 200 Hz. From this data, power, velocity, and force were calculated using Newtonian physics and results from the best jump (defined as the greater velocity) were recorded and compared between pre and post-conditioning exercise using a paired t-test. Each participant performed lower body and upper body PAP testing on the same day however order was randomized and counterbalanced (see Figure 2).

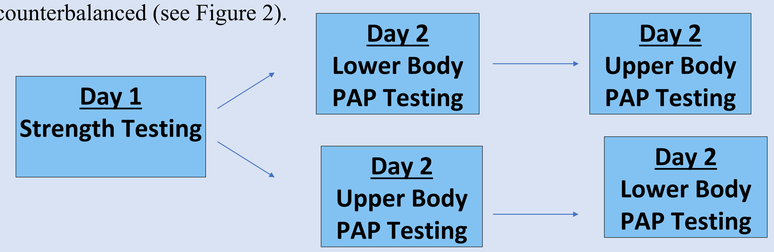

Figure 2: Randomization Pattern of upper and lower body testing.

Results

Peak force significantly increased in the BT after the conditioning exercise but did not significantly change in the VJ (see Figure 3).

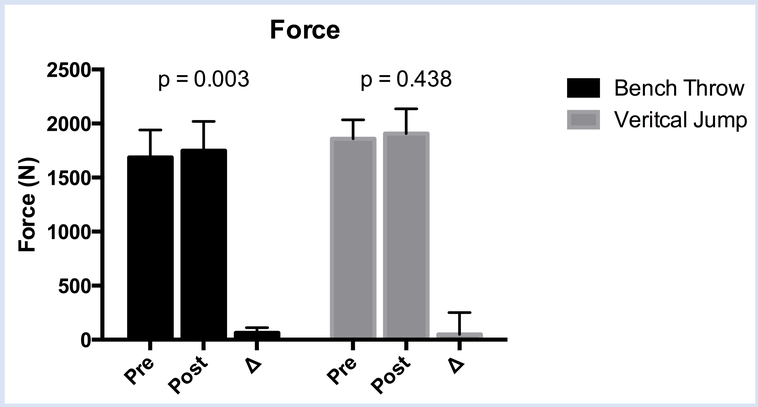

Figure 3. Force during upper and lower body power exercises.

Results

Peak concentric power did not change in the BT or VJ after the conditioning exercise despite a non-significant (p=0.087) decrease in the VJ (see Figure 4).

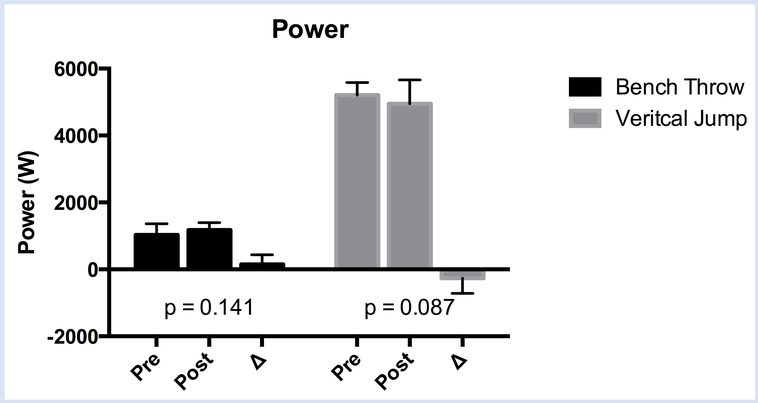

Figure 4. Power during upper and lower body power exercises

Peak concentric velocity did not change in the BT or VJ after the conditioning exercise (see Figure 5).

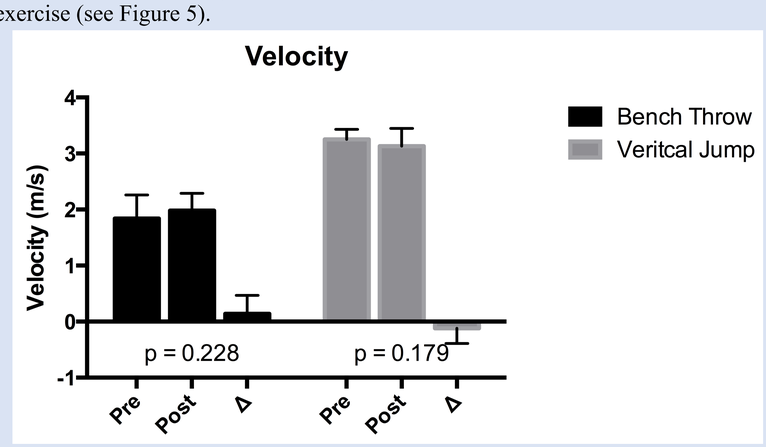

Figure 5. Velocity during upper and lower body power exercises.

Discussion

There are a few points to consider when contemplating why most of our results did not support our Hypothesis.

- It can be seen through literature review, that so called “responders” and “non-responders” to PAP might be determined through training history [4].
- Perhaps our warmup fatigued our participants. It is well known that PAP must balance fatigue and potentiation [5]. Our study included a comprehensive lower body warmup, but no upper body specific warmup. It can be speculated that other studies’ results elicitation of PAP could be attributed to the CA acting as a warmup.

References

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