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THE EFFECTS OF POST ACTIVATION POTENTIATION ON THE HANG POWER CLEAN

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ABSTRACT

The purpose of this study was to determine if implementing a heavy DL warm up (PAP) can improve hang power clean (HPC) performance. Secondarily, it was of interest to determine if there was a meaningful relationship between the DL and HPC one repetition maximums (1-RM). Twelve avid recreational lifters participated in the study (female: n=5, age=29.0±3.2 yrs, height= 171.7±11.9 cm, mass=67.9±20.6 kgs and male: n=7, age=28.9±3.6 yrs, height=178.9±7.6 cm, mass=88.4±11.6 kgs). Participants met on three occasions separated by one week. During week 1 participants established a 1-RM DL. Week 2 half of the participants completed 1-RM HPC, while the other half of the participants completed a 1-RM HPC preceded by a PAP warm-up executed with sets of DLs culminating with one set of one repetition at 90% of 1-RM. Week 3 the participants crossed over with respect to performing the PAP warm-up. A paired t-test was used to compare the mean 1-RM HPCs between conditions and a Pearson correlation coefficient (r) was calculated to compare 1-RM DLs with 1-RM HPCs. The 1-RM hang HPC was significantly greater (≈3.0%) following the DL PAP warm-up ($p<0.01$). The relationship between the 1-RM DL and 1-RM HPC was $r=0.96$ ($p<0.01$), where the 1-RM hang power clean was 54% of the 1-RM DL. Within the parameters of this study, a PAP DL warm-up strategy significantly improved HPC performance. Further, there is a very strong positive relationship between maximum HPC and DL performance.

Keywords: *Post activation potentiation, hang power clean, DL.*

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1. INTRODUCTION

Recently there has been a great deal of interest in post activation potentiation (PAP), defined as an acute enhancement of muscle function following an intense muscle activity (Hodgson, Docherty, & Robbins, 2005). The theoretical mechanisms responsible for the PAP phenomena have been discussed in detail elsewhere (NSAC Hot Topic, 2016). Meanwhile the practical applications of PAP continue to be explored (NSAC Hot Topic, 2016), a practice suggested by Bishop's (2008) applied research model for the sport sciences.

Complex training (a form of PAP) has become popular at sports performance centers. Complex training (CT) is implemented by pairing a heavy slower lift (excitation) followed by an explosive lift or movement within a singular training session (e.g. a heavy back squat followed by a vertical jump). Coaches and athletes have been intrigued by the possibility of using CT to facilitate improvements in athletic performance. The question that is frequently asked in the sports performance industry is: "are there practical ways to use PAP in the form of CT to enhance athletic performance?"

In this regard, the hang power clean (HPC) is an Olympic lift weightlifting variation that is popular among athletes as a way to train for explosive movements required in many sports (O'Shea, 2000). If using a warm-up strategy that involves athletes performing a moderate to heavy load exercise can help increase their HPC through the effects of PAP, then that warm-up strategy would be a practical use of PAP. To date, we are unaware of any research exploring the effect of PAP on of the Olympic lifts or variations thereof.

The purpose of this study was to determine if a warm-up using a using a progression of DL sets culminating in a near maximum DL (PAP) is effective in improving the one repetition maximum HPC (1-RM HPC) as opposed to not using a warm-up with heavy DL. This study also aimed to determine if there is a correlation between (1-RM) DL and 1-RM HPC.

It is hypothesized that warming up with a progression of DLs leading to a near 1-RM DL will be effective as a PAP stimulus resulting in an increase of 1-RM HPC performance. Further, we anticipate a moderate to high correlation between 1-RM DL and 1-RM HPC scores.

2. METHODS AND MATERIALS

2.1 Participants

There were 12 participants in this study, all over 18 years of age. The participants were recreational lifters who had at least six months of experience training with the HPC and DL. There were no requirements for weight, height, or how much

they could lift. There was a range of ages and abilities in the lifters. None of the participants had any injuries preventing them from performing the lifts to the best of their abilities. After an explanation of the study's purpose and procedures, participants signed informed consent forms approved by the University's Institutional Review Board.

2.2 Procedure

The first session (week 1) 1-RM DL was assessed in all participants, and they were randomly assigned into two groups for ease of subsequent assessments. The second session (week 2), the first group's 1-RM HPC was assessed with a standard warm-up (i.e., a progression upward in HPC weight and a decrease in repetitions). The second group started with a DL warm-up. The warm-up progression was five sets of DLs with a three to five minute rest in-between each set. The weights were predetermined from the 1-RM DL each participant did the week before. The warm-up progression was as follows (sets x repetitions x 1-RM load): 1 x 5 x 60%; 1 x 4 x 70%; 1 x 3 x 80%; 1 x 2 x 85%; 1 x 1 x 90%. Participants were then given a seven-minute rest. After this rest period, the participant's 1-RM HPC was assessed as described above. The next week (session three), the two groups crossed over with respect to the warm-up procedures described above, and 1-RM DL and 1-RM HPC were assessed, respectively. Baechle, Earle, and Ratamess (2008) for a detailed description of the biomechanics of performing the DL and HPC. Faigenbaum, McFarland, Herman, Naclerio, Ratamess, Kang, and Myer, (2012) has reported the 1-RM power clean as reliable with a test-retest ICC of 0.98 (95% confidence interval = 0.96–0.99).

2.3 Design and Analysis

A repeated measures cross over design was used in this study. The study commenced with an initial meeting where participants established a 1-RM DL. Subsequently, participants were separated into two groups, each performing two exercise sessions that included the performance of a 1-RM HPC. One session used a typical warm up and the second session used a warm up strategy, including the DL as a potentiating exercise for the 1-RM HPC. The participant groups crossed over with respect to the order of the exercise sessions.

2.4 Statistical Analysis

A paired t-test was used to compare the HPC that utilized a PAP DL to the HPC that did not use a PAP DL warm-up strategy. Statistical significance would be achieved at $\alpha \leq 0.05$. A Pearson Correlation Coefficient (r) was calculated

between the 1-RM DL and non-potentiated HPC in order to determine if a meaningful relationship existed.

3. RESULTS

All of the participants were able to complete the study 1-RM assessments (DL, HPC, HPC with PAP). Table 1 provides the subject descriptive statistics for age height and body mass (mean ± standard deviation). Twelve participants completed the study without injuries or dropouts. Five of the participants were female the other 7 were male.

Table 1: Participant (n=12) means and standard deviations for descriptive information

	Age(yrs)	Mass(kgs)	Height(cms)
Participants (n=12)	28.9±3.3	79.9±18.4	175.9±9.8
Female (n=5)	29.0±3.2	67.9±20.6	171.7±11.9
Male (n=7)	28.9±3.6	88.4±11.6	178.9±7.6

The mean for their maximum DL was 133.8±44.1 kgs. The mean1-RMHPC after performing the DL was 74.6±25.6 kgs. The participants' mean 1-RM HPC when not performing the DLs was 72.5±25.2 kgs. The HPC was significantly greater (≈3.0%) following the DL PAP (p<0.01). Eight of the participants improved their 1-RM HPC following the PAP DL (5-male 3-female) and 4 participants HPC's were identical between the PAP and non-PAP warm-ups (2-male 2-female).

Table 2: All participant (n=12) lifts were measured in kilograms (means and standard deviations)

	1-RMDL	1-RM HPC	1-RM HPC DL PAP	PCC (r) 1-RMDL & 1-RM HPC
n=12	133.8±44.1	72.5±25.2	74.6±25.6*	0.96*

Note[1]: 1-RM-one repetition maximum, DL-deadlift, HPC-hang power clean, PAP-post activation potentiation, PCC-Pearson correlation coefficient.
Note[2]: *significantly greater p<0.01.

The PCC between the 1-RM non-PAP HPC and 1-RM was r=0.96 (p<0.01). The coefficient of determination (CD=r^2) was CD=0.92. The PCC between the 1-RM non-PAP HPC and 1-RM is considered very high (Safrit, & Wood, 1995) and the CD=0.92 indicates that the HPC and DL 1-RMs come from common factors (Safrit, & Wood, 1995).

Table 3: Individual DL and HPC scores (kgs). F-female M-male

Participant	DL 1-RM	HPC 1-RM	HPC 1-RM with PAP	%Δ
1-M	150	85	87.5	2.9
2-M	200	100	100	0.0
3-F	125	85	85	0.0
4-F	80	40	42.5	6.3
5-F	90	45	45	0.0
6-M	180	95	102.5	7.9
7-M	160	92.5	95	2.7
8-M	180	102.5	105	2.4
9-F	60	30	32.5	8.3
10-M	150	75	77.5	3.3
11-M	130	70	70	0.0
12-F	100	50	52.5	5.0

4. DISCUSSION

The purpose of this study was to determine the effects of a PAP warm-up strategy that used a near maximum DL as a potentiating exercise on HPC performance. Secondarily, we also wanted to examine the relationship between the 1-RM DL and 1-RM HPC. The results of this study suggest that the DL PAP warm-up strategy was on average effective at increasing HPC performance (≈3.0%). It was also determined that there was a very high positive correlation between 1-RM DL and 1-RM HPC scores.

The improvement in the HPC as a result of the DL PAP warm-up found in this study is consistent with previous studies which have demonstrated that a PAP warm-up can significantly increase both upper and lower body power output (Harris, Dolny, Browder, Adams, & DeBeliso, 2004; Harris, Moore, DeBeliso, Adams, Berning, & Hansen, 2006; Mallander, Berning, Pederson, Adams, DeBeliso, Stamford, & Maud, 2006; Berning, Adams, DeBeliso, Sevene-Adams, Harris, & Stamford, 2010; Harris, Kipp, Adams, DeBeliso, & Berning, 2011; Dove, Sevene, Harris, DeBeliso, Adams, Carson, & Berning, 2013). The potentiating effect of the DL PAP ranged from no change to an 8.3% increase. Four of the participants experienced no improvement while the other 8 averaged a 4.9% increase in HPC performance. Previous research indicates that the training status of an athlete is the primary factor necessary for a PAP training strategy to be successful (Gullich & Schmidtbleicher, 1996; Hrysomallis, & Kidgell, 2001; Gilbert & Lees, 2005; Kilduff, Bevan, Kingsley, Owen, Bennett, Bunce, …, & Cunningham, 2007). Further, the National Strength and Conditioning Association (NSCA) suggests that PAP protocols should be "reserved for resistance-trained

power athletes with high relative strength" (NSCA Hot Topics, 2016). The participants in this study were screened so that they were at least 18 years of age and had at least 6 months of experience performing HPCs and DLs. With that said, the participants in this study clearly did not meet the NSCA's PAP recommendations. Hence, prior training status and relative strength may have been partially responsible for some of the participants not experiencing any measureable potentiation as a result of the PAP DL protocol used in this study. Conversely, it appears that the training status and relative strength did not completely impede 8 participants from experiencing a potentiating effect of approximately 5%. Albeit, the potentiating effect may have been even greater if the participants were more advanced resistance trained athletes. Hence, the positive results of this study suggest that exploring PAP protocols in recreational level athletes requires further investigation.

The success of a PAP protocol is based on finding the optimal stimulus that allows for the coexistence (minimization) of fatigue while the muscles are in a potentiated state (Rassier, & MacIntosh, 2000). Per this, t is also possible that the volume and/or intensity of the DL PAP warm-up used in this study was too great, leading to a detrimental level of fatigue and hindering the performance of the HPCs. The DL PAP warm-up volume used in this study could be easily modified by reducing the number of repetitions in the DL progression sets as well as reducing the culminating DL from 1 repetition of 90% of 1-RM to 80-85% of 1-RM.

Recovery time following the potentiating exercise has also been shown to be critical with regards to maximizing the outcomes of a PAP protocol where 3-12 minutes has been identifies as ideal in well trained athletes (Gullich, & Schmidtbleicher, 1996; Kilduff, *et al.*, 2007). The current study used a rest period of 7 minutes, which based on our observations was appropriate (the participants appeared rested and ready to get started with the HPCs). However, we feel that the rest period to be employed in a PAP protocol should be developed on an individual basis considering the training status of the athlete as well as how the individual feels on a certain day (sleep, nutritional status, life stresses, etc.).

The potentiating exercise selected for this study was the DL. We chose the DL for two primary reasons. First, no racks were required, just the barbell and weights (the same implements required for the HPC). Second, we felt from a specificity stand point that the DL would tax similar musculature and mechanics as the HPC. In retrospect, a partial DL rack pull may have been a superior choice as the potentiating exercise. The partial range DL rack pull could be started from a position near the starting position of the HPCs eliminating the initial pull from the floor associated with a full range of motion DL. It is conceivable that using a partial DL rack pull as the potentiating exercise could have led to a greater level of potentiation as the amount of weight that could be lifted while performing a

partial DL would be far greater than a full range DL. However an individual would need access to a power rack (or weight stands) in order to implement the partial DL rack pulls.

This study also examined the relationship between the 1-RM DL and 1-RM HPC. The 1-RM HPC was on average 54% 1-RM DL and the PCC was r=0.96. The coefficient of determination (CD=r2) CD=0.92 which indicates 92% of HPC and DL 1-RMs come from common factors (Safrit, & Wood, 1995). In other words, a high percentage of physical attributes that contribute to the performance in one lift also contribute to the performance in the other lift. Given that the DL is a strength movement and the HPC is a power movement it may seem unexpected that such a high relationship would exist. However, this highlights the point that both force and velocity contribute to optimal power.

Coaches could use the information about the correlation and percentage between HPCs and DLs to estimate what an athlete could lift while performing only one of the lifts. This could help estimate 1-RM load, in turn helping with workout protocol design. More importantly, if this correlation held true with a variety of athletes and lifters, it would suggest that improving either an HPC or a DL would improve the other lift at a proportional rate. This relationship could greatly benefit coaches and athletes wanting to improve one of these two lifts. A future study should be done to determine if improving one lift subsequently improves the other.

Coaches and those working with athletes might use this study to rethink how they organize their training sessions. According to the National Strength and Conditioning Association (Baechle, 2008), when organizing a workout, the power lifts should come before the strength lifts. This is typically how strength and conditioning coaches organize their lifts. Oftentimes, they have been concerned that the power lifts would suffer due to the strain of doing the strength lifts first. This study shows that an athlete can do heavy DLs before doing HPCs without compromising HPC performance. This allows coaches to be more efficient with large groups. For example, the coach could have one group do DLs while the others are doing HPC, and then have the groups swap. Complex training has become popular and, as such, coaches could have lifters go back and forth between DLs and HPC.

Finally, coaches who have Olympic lifters could look into using a heavy DL to help warm up for competition. Traditionally the strain of a DL has been thought to hurt an athlete's ability to perform Olympic lifts. Because this study showed 8 lifters improved, coaches could look at athletes on an individual basis and see if it helps an athlete improve in practice. If this helps at practice, then it would be a viable warm-up option for an Olympic athlete before competition. Gaining even small amounts can be important for athletes competing in an Olympic lifting event.

5. CONCLUSIONS

Within the parameters of this study it is concluded that:

- Using a PAP DL warm-up is a viable way to improve 1-RM HPC,
- PAP protocols should not be reserved for advanced resistance-trained athletes with very high relative strength,
- There is a very high relationship between 1-RM HPCs and DLs, and
- The 1-RM HPCs are slightly higher than 50% of 1-RM DLs.

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