THE ACUTE EFFECTS OF UNILATERAL BASED POST-ACTIVATION POTENTIATION UPON SINGLE ARM 4.55kg MEDICINE BALL THROW FORCE/VELOCITY CHARACTERISTICS.

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INTRODUCTION: The use of varying dynamic (concentric, eccentric, coupled actions) (Chui et al. 2003, Rixon et al. 2007, Kilduff et al. 2008, Tillin et al. 2009, Seitz et al 2014 and 2016, Ulrich et al 2017, Wang et al 2017) and isometric (French et al 2003, Rixon et al. 2007, Tillin et al. 2009, Seitz et al, 2016) pre conditioning activities with the aim to induce a transient state of post-activation potentiation has received increased interest over the past 15 years. Small to (1%-5%) moderate statistically significant acute improvements have been reported for Counter Movement Vertical Jump's (CMVJ's) and Squat Jumps (SQJ's) force (N), velocity (m/s), and power (W) and rate of force development (RFD) (French et al. 2003, Chui et al. 2003, Rixon et al. 2007, Kilduff et al. 2008, Seitz et al., 2014). Positive effects have also been seen for; horizontal jumps, initial sprint accelerations and Olympic lifts (Kilduff et al., 2009, Seitz et al. 2014 and 2016, Chui et al 2003). Commonly cited mechanisms include; increased Regulatory Myosin Light Chain (RMLCH) phosphorylation , increased inter and intra muscular temperature, as well as reflex potentiation (Tillin et al. 2009, Seitz et al., 2014 and 2016,Chui et al. 2003, Ulrich et al. 2017). PAP has been shown to coexist with fatigue, making the "complex" pairing of exercises, and the respective timing of such groupings crucial to performance outcomes. Common complex pairings have included heavy load back squats followed by CMVJ's or SQJ's, or isometric mid-thigh pulls or quarter squats followed by similar exercises, and for the upper extremities, heavy load bench press followed by bench throws or medball throws. The majority of PAP studies have focused upon the lower extremities, using three to five repetitions (80%-95% of 1RM), or three to five second intermittent exposures (Maximal Voluntary Contractions; MVC"S) with 1 to 3 minutes rest periods between exposures. More recently, ascending load 1RM assessment protocols have been shown to induce PAP in the same musculature. Heavy load bench presses and push presses followed by bench throws or medicine ball throws have produced mixed results (Esformes et al. 2011, Ulrich et al. 2017, Wang et al. 2017). Fiber type composition, training status, training stage, relative strength level and preexisting fatigue state have previously been highlighted as factors impacting performance outcomes (Chui et al. 2003, Rixon et al. 2007, Kilduff et al. 2008, Tillin et al. 2009, Seitz et al. 2014 and 2016, Ulrich et al. 2017, Wang et al. 2017). Previous upper extremity based protocols have utilized primarily bilateral movements with a smaller portion looking at unilateral movements (Esformes et al. 2011, Ulrich et al. 2017, Wang et al. 2017). Single arm overhead lifts using dumbbells or kettlebells have become increasing more popular with combat sports athletes. The coupling of a split stance, dumbbell push press with a medicine ball throw is a novel pairing to date. Using an ascending load 1RM protocol between timed medicine ball throws may potentiate subsequent throws. Therefore, the purpose of this study was first to test the efficacy of using a unilateral dumbbell variant of the push press upon potentiating, maximal, force and velocity characteristics during unilateral 4.55kg medicine ball throws. Second, to asses any differences between left and right sides, thirdly, to assess whether grouping subjects by; 1RM strength and associated Fmax produced statistically different outcomes, and finally to highlight differences between "responders" and "non-responders" as determined by average percent change over a 7 minute period.

METHODS: Eighteen recreationally (N = 18) trained males, n = 18: 21.76(± 2.55) years; 181.43(± 8.19) cm; 98.74(± 19.69) kg; free of musculoskeletal injury participated in this study. Prior to the testing session, all participants read and signed informed consent and health history documents, which were approved by the Coastal Carolina University's Institution Review Board. Participants' standing height (cm; Detecto, Webb City, MO, USA) and body mass (kg; Detecto, Webb City, MO, USA) were collected prior to testing. Subjects completed a 5-minute, self-selected low intensity warm up focusing on both upper and lower extremities. Following the warm-up and a 3-minute rest, athletes took alternate throws (left then right) at 50%, 75% and then two "maximal" practice throws at 100% of perceived maximal effort. Medball throws where performed using a 4.55kg Asses to Perform (Steam Boat springs, Colorado) "Ballistic ball" containing a Tri-axial accelerometer sampling at 100Hz. Subjects were instructed to remain motionless then following a verbal 3-2-1 count, to throw the ball horizontally as fast and forcefully as possible towards a suspended 250lb heavy bag. Three maximal trials where recorded with the best two with the highest Vmax (m/s) used and averaged for data analysis. Measures of Fmax (N), Pmax (W), and Vmax (m/s) where recorded wirelessly via a hand held IoS Apple ipad (3rd generation, 16B, Cupertino, CA). A 3-minute rest was then taken before starting the unilateral dumbbell push press (ULDPP) 1RM protocol. Ascending load attempts where performed by alternating from left to right arm until a "stable" near maximal effort was reached. All subjects were instructed to press the dumbbell forcefully overhead using leg/hip drive coupled with forcefully extension of the dumbbell overhead. A limit of 36.36kg (80Lb) was imposed due to dumbbell load constraints as well as to enable subjects to generate high relative Fmax and Pmax values, with 4 total subjects successfully reaching this load. Force/velocity measures were assessed by way of a MyoTest (Sion, Switzerland) tri-axial accelerometer, sampling at 500Hz in trainer mode. The Myotest was taped to the side of the dumbbell using strong adhesive tape to minimize medial-lateral and anterior-posterior motion of the accelerometer. A stop watch was used to track time following completion of the 1RM protocol. Subjects then proceeded to perform the same unilateral medball throws at, 3minutes, 5 minutes, and then 7 minutes post ULDPP 1RM protocol. Subjects alternated between left and right hands until 6 total throws over a 7-minute period had been performed.

All statistical analyses were performed using SPSS software (SPSS version 23.0; IBM, New York, NY, USA). Three separate (Fmax, Pmax, Vmax) 2 (ARM) x 4 (%Δ) repeated measures analyses of variance (RMAVONA) were used to highlight any potential differences between ARMS (L/R) or time points (Baseline, %Δ3,% Δ5, %Δ7) or ARMS x Time points interactions. A grouping variable based upon subjects ULDPP 1RM and respective Fmax was used to group subjects into 2 groups of 9. A further RMAVONA was performed using a grouping variable based upon average responsiveness for Vmax only (Average percent change for L and R at %Δ3, %Δ5, Δ7; if greater than normalized baseline (100) grouped into responders N = 10, if less than normalized baseline grouped into non-responders N = 8). If estimated sphericity was not verified (via Mauchly's W test) the Greenhouse-Geisser correction was applied. Initial statistical significance was set at an alpha level of $p \leq 0.05$, with any statistically significant interactions within the time point conditions being identified using Bonferroni corrected pairwise comparisons.

RESULTS: Descriptive statistics are provided in Table 1. No significant main effects were found for ARM (2), Time point (4) or interaction effects for ARM x Time point (%Δ) or ARM X Time point x Group (Weaker vs Stronger) ($p > 0.05$) for Fmax, Pmax, or Vmax ($p > 0.05$). Body mass (kg) and load during ULDPP (kg) and Fmax during ULDPP stronger > weaker ($p < 0.05$).

Retrospective grouping of subjects based upon average % responsiveness revealed significant between subjects effects for Group (Responder vs Non responder) ($p = 0.00$, Partial $Eta^2 = .691$, $1 - \beta = 1.00$) and Group x time point (%Δ) interaction ($p = 0.002$, Partial $Eta^2 = .262$, $1 - \beta = .930$, 5min %Δ > than baseline and 7 min %Δ for Vmax ($p < 0.05$)).

Table 1. Descriptive statistics for Height (cm), Weight (kg), Age (Yrs), ULDPP 1RM (kg) and ULDPP Fmax (N) ± SD.

Group	Height	Mass	Age	ULDPP 1RM	ULDPP Fmax
Stronger(n = 9)	183.33 ± 6.89	103.13 ± 18.91*	22.07 ± 2.52	35.44 ± 1.10*	820.11 ± 172.49*
Weaker (n = 9)	179.20 ± 9.16	94.34 ± 20.57	21.44 ± 2.70	31.72 ±2.06	638.78 ± 109.02

* Denotes stronger > than weaker ($p < 0.05$)

Table 2. Depicting Means ± SE for %Δ for Vmax (m/s) over 4 Time points post ULDPP 1RM protocol.

Vmax (m/s)	TIME POINT	MEAN	SE	Lower 95% CI	Upper 95% CI
Responders	Baseline	100	.000	100.000	100.000
(N= 10)	%Δ3	103.649*	2.736	97.848	109.449
	%Δ5	107.149*	2.435	101.987	112.312
	%Δ7	103.188*	2.515	97.857	108.519
Non Responders	Baseline	100	.000	100.000	100.000
(N = 8)	%Δ3	87.267	3.059	80.781	93.752
	%Δ5	90.675	3.723	84.904	96.447
	%Δ7	93.869	2.812	87.909	99.829

*denotes significantly great PAP at %Δ3, %Δ5, %Δ7 for "Responders" compared to "Non Responders" ($p < 0.05$)("Responders" N = 10, Stronger n = 5, Weaker n = 5 vs "Non Responders" N = 8, Stronger n = 4, weaker n = 4) (Collapsed over ARM L/R and "Stronger" vs "Weaker") with 95% Confidence intervals.

DISSCUSSION: The initial results from this study revealed no significant PAP afforded by the ULDPP 1RM protocol within or between groups or between left and right sides. Large between subject variation as evidenced by large standard deviations and Standard Errors appears to have negated any significant differences. Previous work has highlighted that temporal profiles for PAP effects in the upper extremities appear to be highly individualized. Practical trends in favor of PAP for the stronger subjects at the 5 minute mark falls in line with previous PAP studies targeting the lower extremities. Eighty nine percent (2 out of 18) of subjects reported being right handed. When looking at medball Vmax data at 5 min post the greatest practical change (5.19%) was seen for the left hand of the "strongest" subjects. Further analysis of the data grouped by strength level and responsiveness to the pre-conditioning PAP stimulus revealed significant differences between "stronger" and "weaker" subjects as well as an interaction between "responders" and "non responders" and %Δ. When looking at subjects responsiveness when grouped by baseline strength level and resultant PAP response, "Stronger Responders" (n = 5) saw a 10.72% and 14.51% increase respectively for the left and right arm for Vmax at 5 minute post compared to a "Weaker Responders" (n = 5) who saw a 7.12% increase and 3.25% decrease. This is in stark contrast to "Weaker non responders" who saw a 9.33% and 13.54% reduction and "stronger non responders who saw 6.46%, and 7.10% reduction respectively at the same time point. These findings further highlight the role of baseline strength upon responsiveness to PAP while also highlighting greater responsiveness in the non-dominant arm. It is possible that the same relative load used during the ULDPP 1RM protocol produced greater relative precondition muscle activity in the non-dominant arm due to the arm being weaker (leading to a greater relative effort, ie closer to true 1RM measure) and less proficient at unilateral movement. Future studies should focus upon using more traditional 3x3 or 3x5 set/repletion schemes using the ULDPP with relative loads ranging from 80% - 95% of 1RM as well medicine balls of different mass. Such complex pairings could prove valuable to striking and throwing based athletes.

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