POTENTIATION EFFECTS OF BALLISTIC VS. NON-BALLISTIC CONCENTRIC-ONLY HALF-SQUATS: PRELIMINARY FINDINGS

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INTRODUCTION: Strength and conditioning practitioners use a variety of training strategies to improve the performance of their athletes. A strength training technique that has become the subject of frequent investigation is postactivation potentiation. Postactivation potentiation (PAP) has been defined as an acute enhancement in muscle performance as a result of contractile history and is considered the basis of complex training (Robbins, 2005). Through the use of PAP, researchers have attempted to identify stimuli that will acutely improve the subjects' overall performance. By identifying stimuli that will improve an individual's subsequent performance(s), it may be possible to use PAP as a training mechanism.

Previous research has indicated that partial range of motion squats may aid in the improvement of maximal strength and early (< 250 ms) force-time characteristics (Bazyler et al., 2014). If performed in a concentric-only motion, partial range of motion squats can limit excess fatigue by eliminating additional eccentric muscle actions. Despite their training benefits, only one study has investigated the potentiation effects of concentric-only half-squats (CON-HS). Dechechi et al. (2013) compared the effect of CON-HS with eccentric half-squats performed at the same load on 50m sprint performance. Their results indicated that the CON-HS protocol produced a statistically faster 50m sprint time, as compared to baseline measurements, whereas the eccentric half-squat protocol did not produce a statistically significant change in performance. Although the previous study indicated that CON-HSs may be effective in eliciting a potentiation effect, it is currently unknown whether CON-HS that are ballistic or non-ballistic in nature will produce a superior PAP response. Therefore, the purpose of this study was to examine and compare the effects of ballistic and non-ballistic CON-HS on squat jump (SJ) performance at various rest intervals.

METHODS: Eleven resistance-trained males (age = 22.5 ± 1.4 years; body mass = 84.7 ± 8.6 kg; height = 179.6 ± 9.1 cm) participated in this study. All subjects provided written informed consent in accordance with the East Tennessee State University Institutional Review Board.

Each subject participated in two familiarization sessions and three testing sessions. The first and second sessions were used to establish the one repetition maximum (1RM) back squat and CON-HS of the subjects, respectively. Prior to 1RM attempts, all subjects completed two minutes of stationary cycling at 50 watts, a dynamic warm-up (lunges, straight leg march, walking quadriceps stretch, body weight squats, etc.), five repetitions at 30%, five repetitions at 50%, three repetitions at 70%, and one repetition at 90% of the subject's predicted 1RM. All back squat repetitions were performed to depth where the subject's hip crease dropped below their knee. All CON-HS repetitions were performed with the barbell starting on the parallel safety bars of the squat rack with the subjects positioned in a 90 degree knee angle. The subjects then performed a concentric-only motion standing up with the bar (Dechechi, et al., 2013).

During each testing session, subjects completed a control (CON), ballistic (BAL), or non-ballistic (NBAL) condition in a randomized order. Prior to each condition, subjects completed two baseline SJs. The CON condition required the subject to complete the same dynamic warm-up described above. The BAL and NBAL conditions required the subjects to perform the same dynamic warm-up before performing a CON-HS protocol that consisted of five repetitions at 30%, three repetitions at 50%, three repetitions at 70%, and two repetitions at 90% of their 1RM CON-HS. The difference between the BAL and NBAL conditions is that all CON-HS repetitions during the BAL condition were completed with the subject finishing the repetition explosively onto their toes. In contrast, the NBAL CON-HS required the subjects to simply stand up without plantar flexion. Following each condition, subjects performed one SJ immediately after the completion of the condition and once every minute for 10 minutes.

All SJs were performed on a dual force plates (2 separate 45.5 cm x 91 cm; RoughDeck HP, Rice Lake, WI) sampling at 1,000 Hz. The SJs were performed while the subjects held a PVC pipe (< 1 kg) across their shoulders, similar to a back squat. Subjects squatted to a knee angle of 90 degrees, received a countdown, and performed a concentric-only vertical jump. Allometrically-scaled peak power (PPa) was calculated for each SJ using the equation [y = peak power / body mass$^{(2/3)}$] (Kraska et al., 2009). The test-retest reliability (ICC) and CV % of PPa were ≥ 0.98 and < 12% for all conditions, respectively. Three paired-samples t-tests were used to compare PPa between the baseline and rest interval where peak performance occurred during the CON, BAL, and NBAL sessions. Effect sizes (*d*) were calculated to indicate practical significance. Visual analysis of the graphed data was also used to interpret the effects of the CON, BAL, and NBAL conditions on PPa.

RESULTS: The PPa data following the CON, BAL, and NBAL conditions are displayed in Figure 1. The greatest SJ performance occurred at three, two, and five minutes post-stimulus during the CON, BAL, and NBAL conditions, respectively. Statistically significant differences in PPa occurred between the baseline and rest interval where peak SJ performance occurred during both the BAL ($p < 0.001$, $d = 0.37$) and NBAL conditions ($p = 0.026$, $d = 0.22$). However, no statistical difference in PPa from baseline to peak SJ performance existed during the CON testing session ($p = 0.111$, $d = 0.20$).

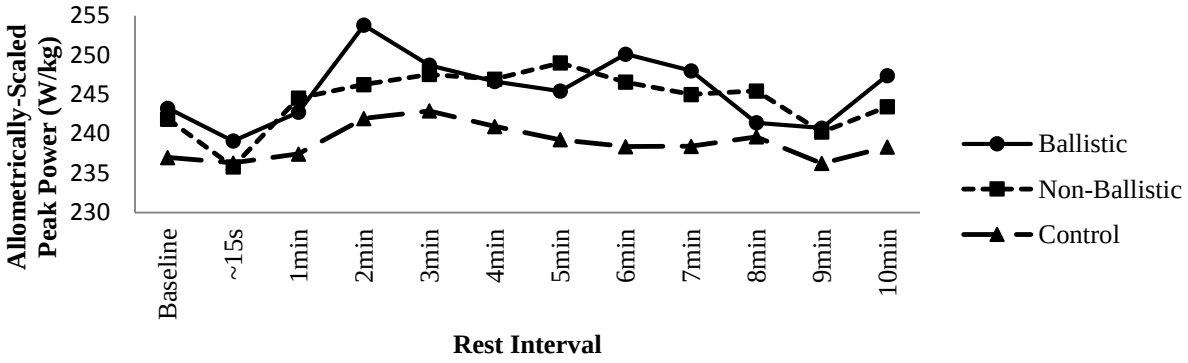

Figure 1. Squat jump allometrically-scaled peak power following the CON, BAL, and NBAL protocols (n = 11).

DISCUSSION: This preliminary investigation examined the acute effects of BAL and NBAL CON-HSs on subsequent SJ performance. Statistically significant differences in PPa were present following the BAL and NBAL conditions, whereas no statistical difference in PPa was present following the CON condition.

Squat jump PPa improved 2.3%, 4.3%, and 2.9% following the CON, BAL, and NBAL protocols, respectively. Furthermore, these differences occurred at three, two, and five minutes following the baseline SJs. The findings of this study are similar to Seitz et al. (2014) who indicated that a ballistic movement (i.e. power clean) elicited a greater magnitude of potentiation compared to a non-ballistic movement (i.e. back squat). It should also be noted that the BAL protocol produced the greatest potentiation three minutes earlier than the greatest potentiation produced during the NBAL protocol. From a practical standpoint, a protocol that produces the greatest amount of potentiation, and produces it at an early rest interval, would appear to be desirable to implement for the acute improvement of SJ PPa. Previous research has indicated that ballistic exercise produces statistically greater muscle activation as compared to non-ballistic movements (Newton et al., 1996). It is possible that the BAL CON-HS examined in this study resulted in the recruitment of higher threshold motor units and/or better synchronization of the recruited motor units, leading to an increase in PAP.

When plotted over time, visual analysis of the current results suggests that the potentiation following BAL CON-HS is tri-phasic in nature in that potentiation peaked at three separate rest intervals (i.e. 2, 6, and 10 minutes post-stimulus). This is similar to the findings of Lamont et al. (2010). It should

be noted that the second peak of the BAL potentiation produced a greater magnitude of PPa as compared to the greatest potentiation produced by the NBAL condition, which provides a further justification for the use of BAL CON-HS as compared to NBAL CON-HS. However, further research examining BAL and NBAL CON-HS is needed.

The preliminary findings of this study indicate that potentiation protocols that include BAL and NBAL CON-HS can acutely improve an individual's PPa during subsequent SJs. The greatest amount of potentiation during the BAL and NBAL conditions occurred two minutes and five minutes post-stimulus, respectively. Ballistic CON-HS produced superior increases in SJ PPa as compared to NBAL CON-HS in resistance-trained males. Practitioners should consider implementing potentiation protocols that include ballistic CON-HS.

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