EFFECTS OF THE SPEEDMAKER DEVICE ON MUSCLE ACTIVITY AND VERTICAL JUMP PERFORMANCE

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This study examined the effects of the SpeedMaker device versus a control condition on jump performance and muscle activity (MA). Female collegiate lacrosse and track athletes (n=16) performed three 45 m sprints at increasing intensities of 80, 90, and 100% of maximum sprint speed either wearing the device or in a control condition. Two minutes after the sprints, athletes performed three maximal countermovement jumps (CMJ) without the device. Variables examined were flight time (FT), peak ground reaction force (PGRF), rate of force development (RFD) and MA during the CMJ. Compared to the control condition, the SpeedMaker device displayed higher PGRF and RFD ($p < 0.05$). There was no difference ($p > 0.05$) for FT or for MA. The SpeedMaker device enhanced some factors affecting jump flight time, but ultimately did not increase flight time or muscle activity.

KEY WORDS: flight time, ground reaction force, rate of force development, post-activation potentiation, electromyography

INTRODUCTION: Post-activation potentiation (PAP) refers to the phenomena whereby muscular performance is acutely enhanced following a previous conditioning contraction (Tillin & Bishop, 2009). Comyns and coworkers (2007) showed that unless the conditioning contraction approached maximum (93% of 1 RM), PAP did not occur. Fatigue can also decrease the PAP response, such as when the conditioning contraction occurs too close to the performance (Jensen & Ebben, 2003; Comyns, Harrison, Hennessy, Jensen, 2006) or when there are excessive contractions (Hamada, Sale, MacDougall, Tarnopolsky, 2003), both of which decrease the PAP response. Esformes et al. (2011) found that there was no difference when either concentric or eccentric contractions were used as the conditioning contraction. Thus, while there are a number of factors that can modify the possibility of PAP, when used effectively in a power-training routine it may enhance the training stimulus (Tillin & Bishop, 2009). While the conditioning contractions typically used to elicit PAP are done with heavy weights, it may be reasonable to assume that other activities that use near maximal contractions, e.g. maximal resisted sprinting, could result in PAP.

In addition to performance modifications, PAP has been shown to increase muscular activity (Gullich & Schmidtbleicher, 1996; Tillin & Bishop, 2009). Gullich and Schmidtbleicher (1996) found an increase in higher motor neuron activity when high intensity conditioning contractions were used prior to performance. While Tillin and Bishop (2009) note that conditioning contractions of greater than 80% are necessary to elicit enhanced muscle activity.

The SpeedMaker device (Elite Athletic Products, San Diego, CA USA) is a training tool that is purported to improve performance. The device has a harness that goes over the chest and waist, as well as straps that go around the lower thighs (see Figure 1). Elastic resistance bands connect the harness around the waist to the thigh straps. The elastic bands serve to resist contraction of the hip extensor muscles (hamstrings and gluteal) during extension. Thus, the device may be used to provide an overload conditioning contraction to initiate PAP.

The purpose of the current study was to examine the effect of wearing the SpeedMaker device as the conditioning contraction for PAP, versus a control condition, on the athlete's vertical jump performance and muscular activity during a countermovement jump (CMJ).

METHODS: Participants were 16 female Division II lacrosse athletes, track sprinters, and jumpers. All athletes completed a Physical Activity Readiness Questionnaire and gave informed consent before the study began. Testing took place on two days not less than 24 nor more than 96 hours apart: an experimental day where the participant wore the SpeedMaker device during the three sprints; and one when the device was not worn. Testing order was randomly assigned for each athlete.

Figure 1: SpeedMaker device worn by one of the athletes.

On both days, the athletes performed a self-selected warm-up consisting of jogging 800 meters and dynamic stretching movements for at least 5 minutes. After the warm up, the participants' muscles were prepared for assessment via electromyography (EMG) of the *biceps femoris* (BF), *gluteus maximus* (GM), and *rectus femoris* (RF). All EMG sites were prepared in the same manner: the selected location was abraded and cleaned with an alcohol pad to reduce skin impedance to < 5 kilo-ohms. Participants were then fitted with Noraxon Dual Electrodes (Product #272 Noraxon USA; Scottsdale, AZ) and surface EMG probes (BTS FreeEMG 300, BTS Bioengineering Corp., Brooklyn, NY) placed on the belly of the muscles according to Cram and coworkers (Cram et al., 1997). Raw data were collected at 1000 HZ, then band pass filtered at 10-450 Hz, full wave rectified, and integrated with a 50 ms moving window (BTS EMG Analyzer, BTS Bioengineering Corp., Brooklyn, NY). Each athlete then performed a maximum isometric voluntary contraction (MVIC) of a quarter-squat to normalize muscular contraction and allow comparison across the muscles.

Following the MVIC the athletes donned the SpeedMaker device for the experimental condition. They then performed three 45m sprints at increasing intensities of 80, 90, and 100% of maximum sprint speed in either the experimental or control conditions. There was two-minutes of rest between each of the three sprints. Following the three sprints and during

a two-minute recovery, the athletes detached the SpeedMaker device, if worn, and stepped onto a force platform (OR6-7-2000; AMTI Watertown, MA USA). They then performed three maximum vertical CMJ with one-minute rest between jumps. The same testing took place on both days.
Kinetic variables were flight time (FT); peak ground reaction force (PGRF) denoted as the highest force observed during the take-off phase; and rate of force development (RFD) during the take-off phase, using a 50 ms moving window as described by Haff et al. (2015).
Comparisons of the FT, PGRF, and RFD between the Control and SpeedMaker conditions was accomplished via a paired t-test. Muscle activity relative to MVIC was analysed via a Two-Way Repeated Measures ANOVA (device X muscle). Statistical analyses were completed using SPSS v. 24.

RESULTS: Paired t-Tests demonstrated higher ($p < 0.05$) PGRF and RFD during the SpeedMaker condition as illustrated in Table 1. Conversely, there was no difference in FT between the two conditions ($p > 0.05$). Repeated Measures ANOVA revealed no main effects ($p > 0.05$) between the muscles or between the control and SpeedMaker conditions (see Table 2). In addition, there was no interaction between the variables ($p > 0.05$).

Table 1
Mean ± SD for Flight time, peak ground reaction force (GRF), and rate of force development (RFD) with and without the SpeedMaker device (n = 16).

	Flight time (ms)	Peak GRF (N)	RFD ($N•s^{-1}$)
SpeedMaker	463.0 ± 77.8	931.0 ± 216.5 *	7217.4 ± 2615.2 *
Control	478.0 ± 64.8	801.1 ± 150.2	5665.4 ± 1883.8

* Significantly higher than Control condition ($p < 0.05$).

Table 2
Mean ± SD for muscle activity relative to MVIC (%) of the Rectus Femoris, Biceps Femoris, and Gluteus Maximus with and without the SpeedMaker device (n = 7).

	Rectus Femoris	Biceps Femoris	Gluteus Maximus
SpeedMaker	208.5 ± 78.0	252.2 ± 132.6	436.2 ± 388.0
Control	195.2 ± 128.7	272.1 ± 149.6	223.7 ± 104.7

DISCUSSION: The main finding of the current research was that compared to a control situation, the use of the SpeedMaker resistance device during three 45m sprints resulted in increased vertical ground reaction force and rate of force development during the take-off of a subsequent CMJ. Conversely, there was no difference in flight time during the jumps when comparing the control and SpeedMaker conditions. These findings are in agreement with Comyns et al. (2007) who stated that alterations in coordination following the resisted condition may explain the lack of difference in flight time despite PGRF and RFD differences.
Similar to the lack of difference in flight time, there were no differences in muscle activity between the control and SpeedMaker conditions for any of the muscles studied. The lack of difference could be due to a number of reasons. Previous research has shown that the presence of PAP may be overshadowed by fatigue if the performance is too close to the conditioning contraction (Comyns et al. 2006; Jensen & Ebben, 2003; Tillin & Bishop, 2009). That is unlikely to be the case in the current study, as the time between the final conditioning contraction and the CMJ was similar to what Comyns and colleagues (2006) found to be the most common interval to show PAP results for women. Nevertheless, due to inter-individual differences in when PAP may occur (Comyns et al., 2006; Gullin & Schmidtbleicher, 1996; Tillin & Bishop, 2009), it is possible that the time interval was not optimal for the current participants.

CONCLUSION: The use of the SpeedMaker resistive device did not result in improved jump performance or enhanced muscle activity following maximal sprinting. However, there were improvements in some jump take-off parameters, specifically peak ground reaction force and rate of force development. Thus, further study on using the SpeedMaker device to enhance jump performance following maximal sprinting is recommended.

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