INFLUENCE OF A SELF-INDUCED DROP ON VERTICAL JUMP PERFORMANCE

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INTRODUCTION

Countermovements are valuable because of the exploitation of the stretch-shorten cycle. In a traditional countermovement vertical jump athletes lower the center of gravity by flexing the hips and knees, stretching the muscles eccentrically, before changing directions and forcefully extending in the direction of motion. A slight alteration of the countermovement was witnessed by Angle, Gillette, and Weimar (2012) in canine sprinters. The authors noted that unlike the traditional countermovement (CM) typically seen in humans, canines flexed the elbows and knees to raise the paws 4-8cm from the ground allowing the center of mass to free fall toward the ground. Upon contacting the ground the joints flexed farther prior to take-off [1]. Canines appear to perform a self-induced drop. Drops have been associated with higher rate of force development (RFD), which is associated with improved vertical jump performance [2, 3]. Hence, a self-induced drop should lead to increased RFD and increased jump height. Therefore, the purpose of this study was to compare rate of force development and vertical jump height in the self-induced drop (SD) to the countermovement (CM) and squat jump (SJ) conditions.

METHODS

17 males and 17 females were recruited for participation. Participants performed a minimum of 3 maximum vertical jumps utilizing 3 different loading conditions (SD, CM, SJ). Arm swing was not allowed in any of the jumps. The order of the loading conditions was randomized. The SD required participants to lift their feet from the ground without vertical rise in the center of mass, and fall into a countermotion. The second condition was the CM in which the center of mass lowers prior to the push phase with the feet in contact with the ground. Additionally a SJ condition was performed with the knees pre-flexed to a self-selected depth. Each jump was recorded using a 10-camera Vicon® MX motion capture system (Vicon®, Los Angeles, CA, USA) with a sampling frequency of 200 Hz. Jump height was defined by the difference in maximum height achieved of the greater trochanter marker and its height during the static calibration trial.

RESULTS AND DISCUSSION

A two-way repeated measures ANOVA was used to analyze differences in jump height (Figure 1). The results of the analysis indicated significant differences among conditions ($F(2,64) = 33.738, p < 0.001, \eta^2 = 0.513, Power = 1.000$) and both sexes had the same response to the imposed conditions ($F(2,64) = 2.512, p = 0.089, \eta^2 = 0.073, Power = 0.486$). Pairwise comparisons demonstrated that jump height in the CM was significantly greater than the SD ($p = 0.014$) and the SJ ($p < 0.001$). Additionally, height in the SD was significantly greater than the SJ ($p < 0.001$).

**Figure 1**: Mean vertical jump height for each SSC condition. * denotes significance at the $p = 0.05$ level.
A two-way repeated measures ANOVA was used to analyze differences in RFD. RFD results violated the sphericity assumption requiring the Greenhouse-Geisser adjustment to the degrees of freedom. The results of the analysis indicated significant differences among conditions ($F(1.297, 41.491) = 15.104$, $p < 0.001$, $\eta^2 = 0.321$, $Power = 0.987$) and both sexes had the same response to the imposed conditions ($F(1.297, 41.491) = 1.875$, $p = 0.177$, $\eta^2 = 0.055$, $Power = 0.300$). Pairwise comparisons demonstrated that RFD in the SD was significantly greater than the CM ($p < 0.001$) and the SJ ($p = 0.025$). Additionally, RFD in the SJ was significantly greater than the CM ($p = 0.009$).

Results indicate that the CM is superior to both the SD and SJ conditions in producing maximum jump height. This occurred despite greater rates of force development in the SD condition. It is possible that the rate of force development is too high in the SD condition, especially since the condition was novel to all participants. High rates of force development can lead to muscle fiber lengthening [4]. Muscle fiber lengthening, although it allows for force enhancement, may necessitate greater shortening of the muscle during the concentric phase of the jump. Increased shortening suggests the muscle operates too far to the right on the force-velocity curve, which leads to non-optimal force production.

However, participants did jump higher in SD compared to SJ. The results demonstrate that utilizing the stretch-shorten cycle improves performance.

**CONCLUSIONS**

This study examined the CM, SD and SJ vertical jump conditions. Utilization of a stretch-shorten cycle improved RFD and vertical jump height. Although the CM appears to be the superior method, this may be due to non-optimal muscle coordination in a novel jumping technique, which could be corrected with training. Furthermore, the efficacy of the SD condition should be examined in horizontal accelerations, since this is the circumstance noted by Angle, Gillette and Weimar (2012).

**REFERENCES**


