THE EFFECT OF REMOTE VOLUNTARY CONTRACTIONS ON STRENGTH AND POWER TASKS OF WOMEN

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This study evaluated the effect of remote voluntary contractions (RVC's) on the performance of closed kinetic chain exercises. Subjects performed the squat and jump squat in a RVC condition and a condition without RVC's (NO-RVC's). Peak ground reaction force (GRF), rate of force development during the first 100 ms (RFD 100), RFD to peak GRF (RFD-P), and jump squat height (JH) were assessed with a force platform. Data were analyzed with a one way ANOVA. Results revealed there were no significant differences between RVC and NO-RVC conditions for peak GRF for either the squat (p = 0.11) or jump squat (p = 0.47), RFD 100 for either the squat (p = 0.25) or jump squat (p = 0.23), RFD-P for either the squat (p = 0.88) or jump squat (p = 0.38), or for JH for the jump squat (p = 0.68).

KEYWORDS: Concurrent activation potentiation, motor control, ergogenic, training

INTRODUCTION: Concurrent activation potentiation (CAP) has been proposed to enhance prime mover performance via the simultaneous contractions of muscles remote from the prime mover such as jaw clenching (Hiroshi, 2003), which are referred to as remote voluntary contractions (RVC's) (Ebben, 2006). These RVC's have been demonstrated to increase lower body reflexes (Delwaide & Toulouse, 1980; Hortobagyi et al., 2003; Pereon et al., 1995), performance during isometric testing (Ebben et al., 2008a; Sasaki et al., 1998), and the countermovement jump (Ebben et al., 2008b).

A recent review of the literature introduced the concept of CAP and outlined potential methods for optimizing this method of training (Ebben et al., 2006). Since then, researchers studying the effect of RVC's determined that an aggregate of jaw clenching, hand gripping, and the Valsalva maneuver was more effective than jaw clenching or hand gripping alone (Ebben et al., 2008a). The aggregate RVC condition has been shown to produce isometric average torque and peak torque that was 14.6 and 14.8% higher in the RVC compared to the NO-RVC condition (Ebben et al., 2008a). However, given the specious history of the effect of RVC's on muscular performance (Gelb et al., 1996) and the fact that RVC's have been demonstrated to be effective during isometric (Ebben et al., 2008a; Sasaki et al., 1998), but not during some dynamic, tasks (Sasaki et al., 1998). The effect of RVC's on dynamic performance requires further investigation.

Only one published study examined the effect of RVC's during a dynamic athletic event (Ebben et al., 2008b). In this study, subjects produced 19.5% higher RFD and 20.2% faster time to peak force during the countermovement jump while jaw clenching, compared to a non-jaw clenching condition (Ebben et al., 2008b). However, these subjects did not produce greater peak force in the jaw clenching condition. Thus, the potential of RVC's as a potentiation phenomenon for dynamic athletic tasks remains uncertain. The effectiveness of a comprehensive aggregate of RVC's has been demonstrated during isometric testing with men as subjects (Ebben et al., 2008a) but their effect on the performance of dynamic tasks and for women has yet to be investigated. Therefore, the purpose of this study was to compare conditions that included RVC's and a condition that did not (NO-RVC) and the effect on back squat and jump squat performance as assessed with kinetic data.

METHODS: Subjects included 10 women (mean ± SD, age 20.9 ± 1.1 yr; body mass 65.7 ± 4.41 kg) who participated in intercollegiate or recreational athletics as well as lower body resistance training with exercises that included knee extension for at least 2 months. Exclusion criteria included any history of lower limb pathology that resulted in functional limitation of the exercises to be assessed in this study. The subjects were informed of the risks associated with the study and provided informed written consent. The study was approved by the institution's internal review board.

Subjects performed a pre-test habituation and test session. Prior to each, subjects warmed up for 5 minutes of light exercise on a rowing ergometer followed by dynamic stretching. A pre-test habituation session was conducted to determine the subjects' 5 repetition maximum (RM) back squat load and countermovement jump height.

During the test session, subjects performed each of the test exercises including 2 repetitions each of the back squat with their previously assessed 5RM load, and the jump squat with an added load equivalent to 30% of the subjects previously estimated 1 RM of their back squat, in the RVC and NO-RVC conditions. In the RVC condition, subjects were instructed to maximally clench their jaw on a dental vinyl mouth guard (Cramer Products Inc., Gardner, KS), grip forcefully on the barbell and pull it down into their trapezius, and perform a brief Valsalva maneuver during the concentric phase of the exercise. The NO-RVC condition included the subjects using their preferred method of gripping the barbell, performing the exercises with an open mouth and pursed lips to limit the likelihood of jaw clenching, and cycling between inspiratory and expiratory flow in order to reduce the Valsalva effect. These methods were similar to those previously used (Ebben et al., 2008a). The order of the test exercises, as well as the order of the RVC and NO-RVC conditions was randomized. Five minutes of rest was provided between each exercise condition to reduce fatigue and order effects. Subjects were instructed to perform maximally and were encouraged equally for all test sets.

The test exercises were assessed with a 60 x 120 cm force platform (BP6001200, Advanced Mechanical Technologies Incorporated, Watertown, MA). The force platform was calibrated with known loads to the voltage recorded prior to the testing session. Kinetic data were collected at 1000 Hz, real time displayed and saved with the use of computer software (BioAnalysis 3.1, Advanced Mechanical Technologies, Incorporated, Watertown, MA) for later analysis. Peak ground reaction force (GRF), rate of force development during the first 100 ms (RFD 100), RFD to peak GRF (RFD-P), and jump squat height (JH) were calculated from the force-time records consistent with methods previously used (Jensen & Ebben, 2007). All values were determined as the average of 2 trials for each exercise. Peak GRF during the concentric phase was defined as the highest value attained. The RFD-100 and RFD-P were defined as the first peak of GRF minus the initial GRF during the concentric phase divided by the time to the first peak of GRF minus the time of initial GRF, and normalized to one second. These two RFD measures were calculated consistent with the methods used by Jensen et al. (2008) and were used to assess faster and slower components of the stretch shortening cycle based on the concept proposed by Schmidtbleicher (1992).

All data were analyzed with SPSS 16.0 using a one way ANOVA to evaluate the differences between the RVC and NO-RVC conditions. Statistical power (d) and effect size (η_p^2) are reported and all data are expressed as means ± SD. The *a priori* alpha level was set at $p \leq 0.05$.

RESULTS: There were no significant differences between RVC and NO-RVC conditions for peak GRF for either the squat ($p = 0.11$) or jump squat ($p = 0.47$). There were no significant differences between RVC and NO-RVC conditions for RFD 100 for either the squat ($p = 0.25$) or jump squat ($p = 0.23$). There were no significant differences between RVC and NO-RVC conditions for RFD-P for either the squat ($p = 0.88$) or jump squat ($p = 0.38$). There were no significant differences between RVC and NO-RVC conditions for JH for the jump squat (p = 0.68). Data for the squat and jump squat are presented in Table 1.

Table 1. Data presented as mean ± SD for the squat and jump squat for subjects in the RVC and NO RVC conditions.

	Squat			Jump Squat		
	RVC	NO-RVC	%	RVC	NO-RVC	%
Peak GRF (N)	1546.2±186.2	1501.8±181.4	2.9	1422.5±106.7	1417.7±106.8	0.03
RFD 100 (ms)	1004.1±680.8	1517.7±1050.9	-33.9	1707.4±1286.7	2101.9±1749.2	-18.8
RFD to peak	255.2±127.7	261.8±125.2	-2.5	797.2±256.0	840.7±144.2	-5.2
Jump Height (m)	--	--	--	0.13±0.04	0.13±0.03	0.0

DISCUSSION: This is the first study to investigate the effects of CAP during ground based exercises such as the squat and jump squat with women subjects, demonstrating that subjects in the RVC condition, compared to the NO-RVC condition, accrued no statistically significant higher performances for any of the outcome variables assessed.
Previous research examining the effects of RVCs during the squat and jump squat revealed that men accrued a statistically significant advantage in the RVC compared to the NO-RVC condition (Ebben et al., in press). Given the similarity between the studies but differences in the results, the present study raises questions about the effectiveness of RVC's for women subjects.
Previous research using only men as subjects (Ebben et al., 2008a) examined the effect of CAP during ground based closed kinetic chain exercise and demonstrated 19.5% higher RFD during the countermovement jump while in the RVC compared to the NO-RVC condition and higher RFD for a subject sample that included both men and women, though no separate gender bases analysis was performed (Ebben et al., 2008b).
In the present study, the mean RFD values were appreciably lower in the NO-RVC condition, though large standard deviations suggest significant variability in subject ability.

CONCLUSION: Results of this study demonstrate no statistically significant performance increase in the variables assessed when using RVC's. In some cases, the use of RVC's resulted in a non statistically significant decrease in performance. In contrast to other studies, RVC's may only augment performance in men, but not women.

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