DIFFERENCES IN SEMG BETWEEN NORMAL SQUATS AND ACCENTUATED ECCENTRIC LOADED SQUATS IN COMPETITIVE COLLEGIATE WEIGHTLIFTERS

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The purpose of the present work was to compare the effect of accentuated eccentric loaded (AEL) squats to normally loaded (NOR) squats on surface measured muscle activation (sEMG) in competitive weightlifters. Eight experienced, competitive weightlifters (six males, two females) completed both an AEL and NOR squat session (seven days apart), comprised of nine sets of squats, and was identical to their normal scheduled training. sEMG data from the vastus medialis (VM), vastus lateralis (VL), and biceps femoris (BF) was collected (at 1000Hz) during the entirety of the concentric (CON) phases of the AEL and NOR sessions. RMANOVAs (set x session-type) were calculated and no statistical differences were found ($p > 0.05$) while promising statistical effect sizes ($\eta^2_{partial}$ 0.073 to 0.273) were observed.

KEYWORDS: training, athletes, rate of force production

INTRODUCTION: Resistance training modalities overloading the eccentric phase of coupled eccentric and concentric exercises (termed accentuated eccentric loaded or AEL exercise) have been hypothesized to optimize the generation of muscular adaptations to force production and mass. Any adaptations from AEL training are likely due to up-regulation of motor activation patterns or improved synchronization of high threshold motor units (Enoka, 1996; Katz, 1939; Komi, 1984; Nardone et al., 1989).

However, the enhancement of acute performance variables via AEL training is equivocal in the published literature, with respect to the methods of application, populations used, outcome measures assessed, and results (Brandenburg & Docherty, 2002; Doan et al., 2002; Godard et al., 1998; Moore et al., 2007; Norrbrand & Fluckey, 2008; Ojasto & Hakkinen, 2009; Sheppard & Young, 2010; Yarrow et al., 2008). Ultimately, when outcomes from studies involving AEL training are analyzed, no maladaptations are elucidated from the AEL interventions/regimens.

Therefore, the purpose of this work was to identify any overriding effects of AEL squats on levels of activation of the vastus medialis (VM), vastus lateralis (VL), and biceps femoris (BF) when compared to normally loaded (NOR) squats in collegiate competitive weightlifters. Specifically, a comparison of the concentric (CON) phases between the AEL and NOR squat sessions was examined in an attempt to identify any acute effect of AEL over the duration of an entire training session. It was hypothesized that the activation of the quadriceps muscles would be higher during the AEL CON phase when compared to the NOR CON.

METHODS: Eight competitive collegiate level weightlifters (six males; two females; age(yrs): 24.6±5.6; height(cm): 169.6±8.7; body mass(kg): 83.3±19.3; hydration status(USG): 1.011±0.006; 1RM squat to body mass ratio: 1.9±0.4; skinfold thickness(mm): triceps = 18.2±10.2; subscapular = 34.0±11.7; midaxillary = 21.6±9.6; suprailliac = 32.9±12.3; chest = 19.0±8.4; abdominal = 38.5±11.1; quadriceps = 21.5±7.4), all with at least 1 year of continuous training as a weightlifter, participated in this study. Signed consent forms and all testing procedures were in accordance with the University Institutional Review Board.

Subjects were prepared for surface measured electromyography (sEMG) data collection and surface electrodes (Norotrode, Myotronics-Noromed, Inc., Kent, WA) were applied over the muscle belly and parallel to the direction of the fibers of the following right leg muscles: VM, VL, and BF. The ground was placed on the right tibial tuberosity and electronic goniometers (Inline Electronic Goniometer, Noraxon USA Inc., Scottsdale, AZ) were placed along the long axis of the femur and tibia on the lateral surface of the right leg (see Figure 1). Raw sEMG data (sampled at 1000Hz) were band pass filtered (10 Hz – 450 Hz), notch filtered (59.5 – 60.5 Hz), full wave rectified, and root means squared at 100 ms windows.

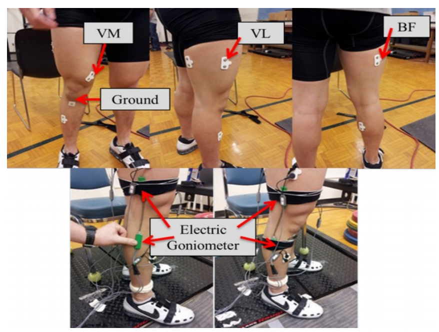

Figure 1: sEMG Set-Up

All subjects completed the AEL squat protocol (see Table 1 & Figure 2) and after seven days, completed the NOR squat protocol (see Table 1 & Figure 3). Rationale for the program creation, percentages used for CON and ECC intensities, and rest periods were based on the subjects normal training routine and published literature concerning similar training modalities (Brandenburg & Docherty, 2002; Doan et al., 2002; Godard et al., 1998; Hortobagyi et al., 2001; Kaminski & Murphy, 1998; Norrbrand & Fluckey, 2008; Sheppard et al., 2008; Sheppard & Young, 2010; Yarrow et al., 2008).

Table 1
Squat Protocols (ECC = difference in kg between 110%/85% sets, added to the associated CON%)

	AEL Squat Protocol			NOR Squat Protocol		
Set #	%1RM	Reps	Rest(min)	%1RM	Reps	Rest(min)
1	20kg	5	3	20kg	5	3
2	40%	5	3	40%	5	3
3	55%	5	3	55%	5	3
4	ECC/55%	3	3	55%	3	3
5	ECC/70%	2	3	70%	2	3
6	110%/85%	1	3	85%	1	3
7	110%/85%	1	3	85%	1	3
8	110%/85%	1	5	85%	1	5
9	55%	5	N/A	55%	5	N/A

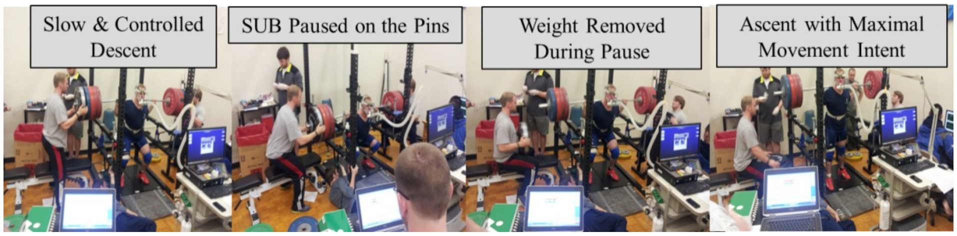

Figure 2: AEL Squat Execution

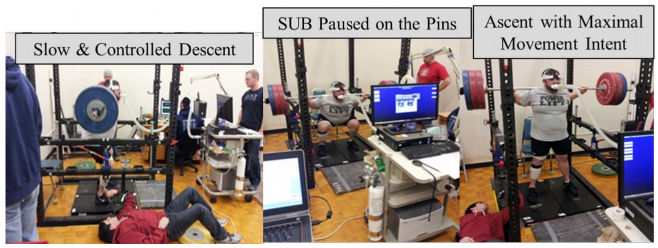

Figure 3: NOR Squat Execution

Three separate, two way 9 (set) x 2 (session type) RMANOVA's were calculated to determine any effect of AEL or NOR squats on surface measured activation of the VM, VL, and BF muscles between phases of squats (AEL CON vs NOR CON); $p \leq 0.05$, *a priori*.

RESULTS: RMANOVA results for each condition and interaction are presented in Table 2. Further analysis was conducted by observing and interpreting the 95% confidence intervals (CI) on matched sets and is addressed in the discussion.

Table 2
RMANOVA Results

	Set x Session Type Interactions		
	Sig Level	ES (Partial $\eta 2$)	Power (1-β)
VM AEL CON vs NOR CON RMANOVA	$p = 0.016$	0.273	0.886
VL AEL CON vs NOR CON RMANOVA	$p = 0.645$	0.097	0.313
BF AEL CON vs NOR CON RMANOVA	$p = 0.810$	0.073	0.232

DISCUSSION: The results from the VL and BF, comparing the AEL CON and NOR CON sessions, identified no statistically significant effect, moderate to large effect sizes, small to moderate levels of statistical power, and a lack of crossover in the 95% CI between matching sets. Results from the VM, comparing the same sessions, did identify an initial statistically significant effect, a small effect size, and a large level of statistical power. However, after an analysis of the 95% CI between matching sets, a lack of crossover of the matched sets dictates no statistical differences between CON phases.

The moderate to large effect sizes and trends to increase during the CON phases elucidate the following points. First, the AEL session resulted in a similar pattern of activation as with the NOR. Second, the large effect sizes, coupled with a lack statistical significance, indicates that if the volume-load of training were greater, subjects may have been able to take full advantage of any effects of AEL squats. Last, measures of sEMG display a tendency to vary during the reproduced levels of force (Bamman, Ingram, Caruso, & Greenisen, 1997; Pincivero et al., 2000; Yang & Winter, 1983) while sEMG may also lack the sensitivity needed to illuminate all changes in muscle activity.

CONCLUSION: The surface measured activation of quadriceps and hamstrings were similar between the AEL CON and NOR CON sessions with respect to statistical significance and power. However, there were moderate to large statistical effects of those differences, especially with the VM AEL CON activation trending higher when compared to the VM NOR CON. Therefore, the applications of AEL squats, to an experienced, strength-trained population would at worse do no harm (with respect to activation) and at best, result in greater levels of activation during the AEL CON phases.

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