ACCENTUATED ECCENTRIC LOADING AND CLUSTER SET CONFIGURATIONS IN THE BENCH PRESS: A PRELIMINARY ANALYSIS

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INTRODUCTION: Resistance training is a powerful tool that improves many performance outcomes including strength and power (Stone, Collins, Plisk, Haff, & Stone, 2000). Several methods of resistance training exist such as traditional strength training, performing weightlifting movements, weightlifting derivatives, plyometrics, and eccentric training (Suchomel, Nimphius, Bellon and Stone, 2018). While these methods are employed at various times during the training plan, coaches are always seeking optimal training methods to improve performance. One method that has been recently explored is accentuated eccentric loading (Wagle, 2019). Accentuated eccentric loading is described as a training method that incorporates loading the eccentric portion of a movement in excess of concentric prescription without interruption of natural mechanics (Wagle et al., 2017).

Research outcomes related to AEL have inconsistent outcomes in relation to force production and explosive performance with studies showing both improvements or no change compared with other training modalities acutely and a lack of long-term studies to draw conclusions (Wagle et al., 2017). Recent investigations comparing AEL with cluster set loading and traditional loading in the back squat exercise provided some evidence of the unique eccentric performance of AEL, but no improvement in concentric performance (Wagle et al., 2018a; Wagle et al., 2018b). Though more studies are being conducted on the application of AEL no consensus has been determined for the proper application of AEL for performance.

Due to the lack of agreement on the application and implementation of AEL further investigations are warranted. The current study was designed to compare the kinetic and kinematic factors associated with inter-repetition performance in different loading prescriptions. Thus, the purpose of this study was to 1) examine the kinetic and kinematic differences between AEL, traditional loading and cluster sets in the bench press exercise and 2) to compare the effects of eccentric loading and inter-repetition rest on concentric performance.

METHODS: Five male subjects participated and completed the study (24.0±4.0 y; 173.5±2.8 cm; 78.3±6.9 kg) with lifting experience (Training Age: 6.8±2.3 y; 1RM Bench: 108.1± 14.8 kg; Relative Strength Ratio: 1.3±0.1 kg) in the bench press exercise to determine the differences between traditional loading, accentuated eccentric loading using weight releasers, and cluster set loading. All subjects read and signed an informed consent prior to participation, which was approved by the university’s Institutional Review Board.

Subjects reported to the lab for a total of five sessions which consisted of a 1-repetition maximum (1RM) testing session and four experimental conditions. All subjects completed a standardized dynamic warm-up before each session consisting of jumping jacks, arm circles, pushups and shoulder taps. The first session was used to determine the 1RM of the subjects to determine their maximal strength and provide eccentric and concentric prescription for the duration of the study. Four randomized loading conditions were implemented to investigate the performance differences between AEL, clusters and traditional loading using a 3x5 rep scheme for each condition. Traditional loading (TRD) was completed with a weight of 80% of the subjects 1RM with no rest between repetitions and three minutes of rest between sets. The traditional cluster set loading condition (TRDC) provided the same 80% prescription as TRD loading but provided 30 seconds of passive rest between repetitions and three minutes of rest between sets. During AEL loading conditions weight releasers were placed on the barbell to provide an additional eccentric loading compared to the concentric prescription. In the AEL cluster (AELC) loading condition all five repetitions in the set received an eccentric overload, but 30 seconds of passive rest was provided between repetitions to load the hooks back on the barbell and 3 minutes rest was provided between sets. During the AEL straight set (AEL1) condition the hooks were only applied during the first repetition while the subsequent reps were completed in a traditional manner with no rest between repetitions and three minutes rest between sets. The loading prescription during AELC and AEL1 was 105% of the concentric 1RM for the eccentric portion and 80% for the concentric portion of the lift for all subjects.

All data was collected using a linear force position transducer (GymAware Version 5: Kinetic Performance Technologies, Canberra, ACT, AUS) attached to a 20kg barbell sampling at 20ms time points and transmits data via Bluetooth to a wireless tablet (iPad, Apple Inc., Cupertino, CA, USA) (Banyard, Nosaka, Sato & Haff, 2017). Data obtained by these methods have been previously determined to be valid and reliable (Banyard et al., 2017). Data were analyzed using Microsoft Excel (Microsoft, Redmond, WA, USA). Mean velocity (MV), mean force (MF), and mean power (MP) were collected and differences were compared between all loading conditions. Descriptive statistics including mean and *SD* were calculated. Cohen's *d* effect sizes were calculated for each dependent variable to determine the magnitude of differences between dependent variables across experimental conditions. Effect sizes were classified as trivial (0-0.2), small (0.2-0.6), moderate (0.6-1.2), large (1.2-2.0), or very large (2.0+) (Hopkins, Marshall, Batterham & Hanin, 2009).

TABLE 1. Descriptive statistics using mean ± *SD*

Variable	TRD	TRDC	AEL1	AELC
Mean Force (N)	858.85 ± 105.69	853.13 ± 100.28	857.77 ± 282.81	856.11 ± 102.64
Mean Power (W)	290.5 ± 84.38	324.84 ± 47.51	282.81 ± 70.06	279.95 ± 70.87
Mean Velocity ($m \cdot s^{-1}$)	0.33 ± 0.08	0.38 ± 0.04	0.33 ± 0.06	0.32 ± 0.06

Note: TRD= Traditional loading condition; TRDC=Traditional loading cluster sets; AEL1=Accentuated eccentric loading for first repetition only; AELC= Accentuated eccentric loading cluster sets

RESULTS: Descriptive data for all conditions can be found in Table 1. Trivial effect sizes were present for all comparisons made between all conditions for MF. Small to moderate effect sizes were present from comparisons for TRDC with TRD (*d* = -0.50), AEL1 (*d* = 0.70), and AELC (*d* = 0.58) for MP. Moderate effect sizes were present for comparisons between TRDC and TRD (*d* = -0.68), AEL1 (*d* = 0.96), and AELC (*d* =0.78) for MV. All effect size and practical interpretations can be found in Table 2.

TABLE 2. Effect Sizes with practical interpretation

Variable	Load Condition	Comparator	Cohen's *d*	Magnitude
Mean Force	TRD	TRDC	0.06	Trivial
		AEL1	0.01	Trivial
		AELC	0.03	Trivial
	TRDC	AEL1	-0.05	Trivial
		AELC	-0.03	Trivial
	AEL1	AELC	0.02	Trivial
Mean Power	TRD	TRDC	-0.50	Small
		AEL1	0.10	Trivial
		AELC	0.14	Trivial
	TRDC	AEL1	0.70	Moderate
		AELC	0.58	Small
	AEL1	AELC	0.04	Trivial
Mean Velocity	TRD	TRDC	-0.68	Moderate
		AEL1	0.12	Trivial
		AELC	0.17	Trivial
	TRDC	AEL1	0.96	Moderate
		AELC	0.78	Moderate
	AEL1	AELC	0.05	Trivial

Note: TRD= Traditional loading condition; TRDC=Traditional loading cluster sets; AEL1=Accentuated eccentric loading for first repetition only; AELC= Accentuated eccentric loading cluster sets

DISCUSSION: The primary purpose of this study was to observe the kinetic and kinematic differences between a traditional load, AEL, and inter-repetition rest on concentric performance. Our results demonstrate better training effects with inter-repetition rest on measured concentric variables. This data agrees with findings by Wagle et al. (2018a, 2018b) who showed that cluster set loading provided favorable outcomes compared with traditional loading and eccentric overload. Our results also indicated that cluster repetitions yield greater concentric outcomes in every set compared to a traditional load, thus suggesting that inter-repetition rest had an influence on concentric performance and may be favorable when using higher loads.

Previous literature has concluded that AEL provides a greater stimulus and therefore greater concentric outcomes compared to a traditional loading (Shepperd, 2010; Hortobagyi, 2001; Doan, 2002). Our findings did not support the notion that AEL conditions have a greater influence on concentric performance compared to a traditional loading. The discrepancies in outcomes may be due to the methodological differences between studies and the acute fatigue that is created from the additional eccentric overload. Recent findings on AEL have shown that inter-repetition rest had the largest influence on concentric performance in the back squat when compared to a traditional and AEL loaded condition. The authors also conclude that the AEL1 and AELC conditions did not have a potentiation effect, which is consistent with our findings (Wagle et.al, 2017).

In the current investigation, AEL and AELC conditions created too large of a stimulus due to a high magnitude of loading and provided similar outcomes to traditional loading. Other studies have looked at submaximal or maximal eccentric loading patterns and found conflicting evidence whether AEL had more favorable concentric outcomes compared to traditional loading (Shepperd, 2010; Ojasto, 2009; Doan, 2002; Hortobagyi, 2001; Godard, 1998). One study compared different additional loads and saw the greatest decrease in concentric performance at 120% of the subjects concentric 1RM (Ojasto et. al, 2009). It seems that depending on the magnitude of the stimulus in the concentric portion of the movement, studies define an increase in concentric performance as either an increased force output (during supramaximal loading) or increased concentric velocity (during submaximal loading). Although there has been favorable evidence for the application of AEL, further research is warranted on distinguishing an optimal loading prescription.

In conclusion, these findings are consistent with previous literature that suggest inter-repetition rest can further enhance concentric outcomes greater than a traditional loading protocol. However, based on these findings and findings from the previous literature, this study suggests that cluster sets provide a unique loading stimulus compared with traditional loading. Based on the current evidence supporting this advanced type of training, AEL serves as a promising tool for strength and power development and should be implemented into a strength and power phase of a progressive training prescription.

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