CONSIDERATION FOR USING MULTI-JOINT, LARGE MUSCLE MASS EXERCISES AND ONE-REPETITION MAXMIMUMS: A CASE STUDY

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INTRODUCTION: Evidence for Block Periodization has theoretical (Minnetti 2002; Zampero et al. 2002; Cunanan et al. 2018; Hornsby et al. 2018), evidence based (Carroll et al. 2018; Painter et al. 2012; Painter et al. 2018) and practical underpinnings (DeWeese et al. 2015a and b). Recently, several authors have challenged the efficacy of this conceptual paradigm, particularly as it relates to the accumulation phase (i.e., hypertrophy emphasis) and the role of enhanced muscle cross-sectional area (CSA) and its effects on maximum strength. Mattocks et al.(2017) and Dankel et al (2017) indicate that muscle hypertrophy resulting from higher volume resistance training plays no role in augmenting strength. This group argue that to achieve gains in maximum strength the initial increases in CSA are of no benefit and that consistently working at or near the one-repetition-maximum (1RM) provides the same (or better) improvements in maximum strength. They suggest that, as the nature of dynamic strength-training is strongly task specific that maximum strength should be measured in some relatively non-specific manner (e.g. isometric). While this challenge has been criticized both conceptually and methodologically Hornsby et al. (2018) further examination is in order. While resistance training exercises are quite task specific (Gibbon et al.2017) carryover to non-specific tests and performances has been consistently demonstrated (Brownstein 2018). It appears that the closer the positional, kinetics and kinematics aspects of the training exercises to the test or performance, the greater the transfer (Stone et al. 2002). In this context, evidence strongly indicates that using multi-joint exercises for large muscle mass have greater transfer to tests and sport performance compared to single joint training (Augustsson et al. 1998; Stone et al. 2002). As the training of athletes should transfer to testing and performance as much as possible, typically multi-joint exercises are used (Stone et al. 2002). It appears that the challenge is largely base on two studies using single joint exercises (Dankel et al. 2017; Mattocks et al. 2017). Furthermore, they used untrained subjects, who may not adapt as do more experienced subjects (Mangine et al. 2018). Thus a logical extension of these arguments would be to examine the use of multi-joint exercises in a block periodization programming paradigm comparing trained versus untrained subjects. However, through experience and experimentation (Fry et al. 1994; Fry et al. 2000; Fry et al. 2004; Fry et al. 2006), use of these larger exercises with high intensities for relatively long periods (i.e. > 3-4 weeks) can be quite fatiguing (Kellman 2010) and counterproductive. Thus, the purpose of this case study was to observe the efficacy of high intensity (at or near 1RM) multi-joint exercises on maximum strength and power. This information was used, in part, to determine the suitability of multi-joint lifts for a multi-subject study.

METHODS

Subject: One moderately trained male (28 yrs; 103 kg; 177cm) with resistance training experience of 14 years participated in this study. Strength and vertical jump values are shown in Tables 1 and 2. The study was approved by the University's Institutional Review Board.

Performance Testing: maximum strength: 1 RM squat, mid-thigh pull, deadlift (specific) and isometric mid-thigh pull (non-specific, IMTP), power: loaded and unload jumps. Warm-up for the 1RM tests was based on Fry et al. (1994). Due to the nature of training, 1RMs were performed as a part of training. Using these methods, the reliability (ICC) for 1 RMs in our laboratory has consistently been > 0.95. Isometric mid-thigh pulls were performed using standardized methods (Beckham et al. 2018), in a custom designed rack on dual force plates (1000 hz); ICC for isometric peak force has consistently been r > 0.95 and rate of force development (RFD) from 0-200 ms r > 0.75. Unweighted (0 kg) and weighted (20 kg bar) static jumps (SJ) were performed after a standardized warm-up consisting of 3x5 mid-thigh pulls at 60 kg, Jumps were performed on dual force plates sampling at 1000 Hz; ICCs for SJ height has consistently been r > 0.90. All tests were performed at 0 weeks and at 5 weeks. Back squat (BS), bench press (BP), deadlift (DL), and Profile of Mood States (POMS) tests were performed one week after training ended. For each testing session, jumps preceded IMTP and all laboratory testing session occurred at least 48 hours after the last training session.

TABLE 1. Strength and jump data

	1RM Assessment						**Laboratory Assessment**				
	SQ	**BP**	**MTP**	**DL**	**SPr**	**PRow**	**IPF**	**IRFD**	**SJH0**	**SJH20**	**POMS**
Pre	148	102	166	150	73	80	2966	4020	26.5	23.5	77
Post	145	100	161	150	77	84	2988	3286	29.0	19.5	133
Δ%	-2	-2	-3	0	6	6	1	-18	7	-17	73
1 Wk Post	148	105		150							102
Δ%	0	2		0							32

Note: SQ=back squat (kg); BP=Bench Press (kg); MTP=mid-thigh pull (kg); DL=deadlift (kg); SPr=standing press (kg); PRow=prone row (kg); IPF: isometric peak force (N); IRFD: isometric rate of force development ($M \times s^{-1}$), SJH0=squat jump height 0kg; SJH20=squat jump height 20kg; POMS=Profile of Mood States.

Mood State and Exertion Assessment: Two hours after each training session, session rate of perceived exertion (sRPE) using the Borg Scale was recorded. The POMS questionnaire was recorded on training days approximately 30 minutes before sleeping at night.

Training: Training was performed 3 days per week for 5 weeks. A 1RM was achieved for each lift on every training day (Fry et al. 1994). The 1RM's during the first and fifth week were used as the maximum values for analysis. On Mondays and Fridays, the subject performed BS, standing press, and BP. On Wednesdays, the subject performed deadlift, MTP, and prone row. Approximately 8-10 total lifts (warm-up to 1RM) were achieved for each lift on each day.

Statistical Analysis: All measures were assessed as percent change (Δ%) pre-post 5 weeks and 1-week post intervention (Table 1). Session RPE and POMS was evaluated as total mood disturbance (Table 2).

RESULTS: All training lifts decreased from pre- to post-intervention. However, SQ and DL returned to baseline 1-week post-intervention whereas BP increased by 2%. Isometric RFD and SJH with 20kg decreased along with negative increases on the POMS report. Isometric MTP IPF and SJ with 0kg increased.

TABLE 2. Session RPE and POMS

	sRPE	POMS
Pre	3	77
Post	6	133
Δ%	100	73
1 Wk Post	5*	102
Δ%	66	32

sRPE=session Rate of Perceived Exertion; POMS=Profile of Mood States. *after re-test of maximum dynamic strength

DISCUSSION: Based on the results of this 5-week observation and that of previous study (Fry et al. 1994, Fry et al.2000; Fry et al. 2004) with multi-joint exercises; consistently using relative intensities at or near 1RM values does not appear to have a particularly efficacious outcome. Based on percentages only those exercises that were relatively unfamiliar (i.e. press, row) showed a small increase.

Although the challenge is correct in pointing out the highly task specific nature of exercises, especially at high intensities, they likely underestimate the degree of transfer. Indeed as pointed out by Augustsson et al (1990) and Stone et al. (2002) transfer to non-training test and performances does occur. The key to transfer appears to be mechanistic shared variance, that is the more underlying mechanisms and kinetic and kinematic characteristics that are shared the greater the transfer (Stone et al. 2002). It should be noted that a cornerstone of block periodization is the purposeful alteration in training emphasis from less specific to more specific over time in order to enhance transfer.

While Dankel et al. (2016) and Mattocks et al. (2017) indicate the measurement of maximum strength alterations should be non-specific (e.g. train dynamically test isometrically), it should be noted only testing non-specifically may mask the actual gains in a training exercise that are more likely to transfer to performance.

Another potential problem with the challenge is failure to note the accumulative fatigue problems associated with consistently using high intensities in training (Hornsby et al. 2018). While this can be a problem with single joint movements the problem is likely compounded when using multi-joint large muscle mass exercises (Kellman 2010). Indeed, in the present observation total mood disturbance and subjective feelings of fatigue were greatly elevated after only 5 weeks and remained elevated 1 week later.

CONCLUSION: Based on this observation, theoretical considerations and agreement with previous study, the use of multi-joint exercises in a prolonged observation (> 3-4 weeks) would not result in efficacious alterations in performance and may be counterproductive, particularly among previously trained subjects.

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