RESEARCH HIGHLIGHTS

The Effect of Rest Redistribution on Kinetic and Kinematic Variables During the Countermovement Shrug

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Introduction

Weightlifting pulling derivatives, which emphasise rapid force development of the lower limbs but omit the catch phase associated with traditional weightlifting exercises, allow for supramaximal loads (i.e., greater than the one repetition maximum [1RM] power clean [PC]). For this reason, they are widely programmed. Performing multiple repetitions consecutively (i.e., traditional sets [TSs]) has been shown to reduce velocity and barbell displacement in weightlifting derivatives (1-4) and increase the rating of perceived exertion (RPE) (3), leading to lower power outputs (2). To maintain kinetic and kinematic outputs during weightlifting exercises, intraset rest periods, termed 'cluster sets' are frequently prescribed (1-4). Although cluster sets are a viable and effective method of exercise prescription, the time taken to complete training may not always be feasible within programmes that are time-constrained. Therefore, redistribution of the total rest time (rest redistribution [RR]) to create more frequent, lower-volume sets (with some of the between-set rest time used intraset) has become a point of interest for strength and conditioning professionals in an attempt to minimise fatigue (3) and maintain kinetic and kinematic outputs (1,3,4). The reduction in rest between sets may reduce effectiveness in minimising fatigue or maintaining kinetic and kinematic outputs, but it is a more time-efficient strategy. It was hypothesised that RR protocols containing shorter but more frequent rest periods would result in a greater peak force (PF), impulse (IMP) and peak system velocity (PV) over multiple repetitions of the countermovement shrug (CMS) exercise (Appendix 1), while also resulting in a lower RPE than in TSs, in line with previous findings (1,2,4).

Methods

This study used a within-subject repeated-measure research design, whereby kinematic (PV) and kinetic (PF and IMP) and RPE variables were determined during the CMS performed with a relative load of 140% 1RM PC, using three different set configurations. The variables were calculated from the force–time data collected with subjects performing all repetitions on a force platform. Twenty-one men (age 27.2 ± 3.3. years, height 1.78 ± 0.07 m, body mass 77.2 ± 10.6 kg, relative 1RM PC 1.22 ± 0.16 kg·kg^{-1}) performed the CMS using 140% of 1RM PC with 3 traditional sets of 6 repetitions (TS), 9 sets of 2 repetitions with RR and 6 sets of 3 repetitions with RR (Figure 1).

The subjects completed a standardised warm-up of low-intensity cycling for 5 min and the CMS for sets of 5, 4, 3, 2 and 1 repetition at 50%, 60%, 70%, 80% and 90% of 140% 1RM PC for one of the following randomly assigned protocols: 3 TS of 6 repetitions with 180 seconds of interset rest (2 × 180 = 360 seconds of total rest), RR protocols of 9 sets of 2 repetitions with 45 seconds of interset rest (8 × 45 = 360 seconds of total rest [RR45]) and 6 sets of 3 repetitions with 72 seconds of interset rest (5 × 72 = 360 seconds of total rest [RR72]), with all subjects successfully completing a total of 18 repetitions in each of the 3 experimental sessions, which were separated by 48–72 hours. For each protocol, the absolute values of PF, PV, IMP and RPE were each combined and averaged across all 18 repetitions for each set configuration. The subjects were instructed to exert maximal effort.

Vertical ground reaction force (VGRF) data were averaged across the first second while the subjects stood still (this average value represented the system weight). The velocity of the system (barbell plus body) was calculated from VGRF force–time data. The acceleration–time record was numerically integrated using the trapezoid rule to yield the velocity–time record (7). The subjects were instructed to exert maximal effort. Impulse was calculated as the area under the force–time curve. All lifts were performed in a power cage (Fitness Technology, Adelaide, Australia) on the Fitness Technology 700 Ballistic Measurement System with an integrated force plate (400 Series) that sampled at 600 Hz and was interfaced with a desktop computer and ballistic measurement software.

Two-way fixed-effect model intraclass correlation coefficients (ICCs) and coefficients of variation (CV%) were used to determine the reliability and variability of performance measures. Differences between protocols were determined using repeated-measure analysis of variance with Bonferroni *post hoc* analysis. Standardised differences were calculated using Hedges' *g* effect sizes, which defined values as trivial (≤0.19), small (0.20–0.59), moderate (0.60–1.19), large (1.20–1.99) and very large (2.0–4.0). An *a priori* alpha level was set at $p \leq 0.05$.

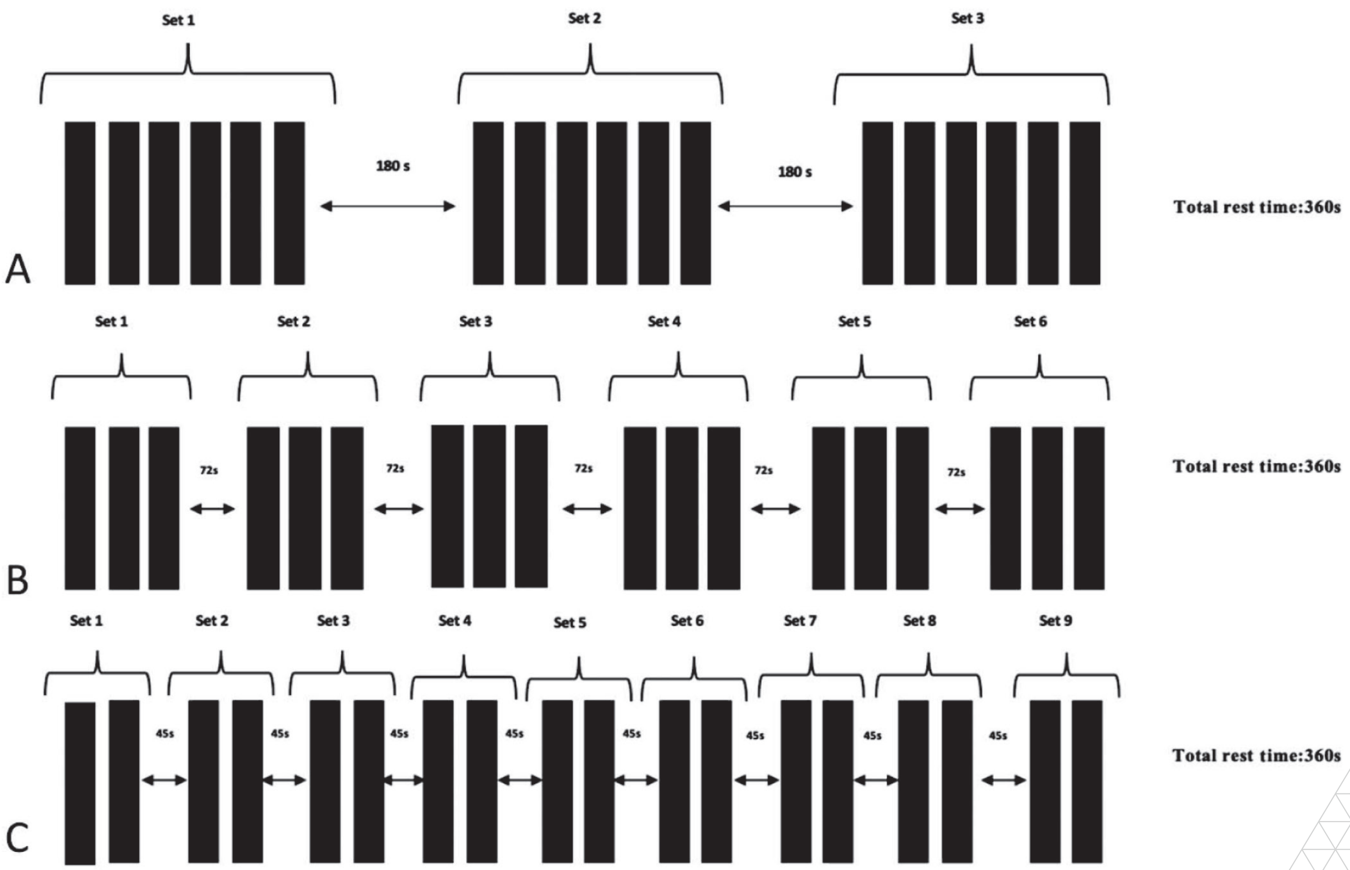

Figure 1. Set protocols.

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Results

PC 1RM performances were highly reliable (ICC = 0.96, [95% CI = 0.83–0.98], CV% = 2.4% [1.7%–3.1%]) between session 1 (92.8 ± 13.3 kg) and session 2 (90.6 ± 12.0 kg). The CMS kinetics and kinematics assessed in this study have previously been reported to demonstrate moderate-to-excellent reliability and acceptable variability within our facility. There were no significant or meaningful differences (p > 0.05, g = 0.00–0.15) between set configurations for any variables.

Discussion

The main finding was that when compared across all 18 repetitions, RR protocols did not result in greater kinetics (PF, IMP) or kinematics (PV) compared with TS protocols (Figures 2a-c), highlighting that shorter, more frequent rest periods during the CMS may not be required to maintain force–time characteristics. Measurement of RPE across entire set protocols was not significantly different in RR protocols compared with TSs, which is not surprising given that there were no significant differences in kinetics or

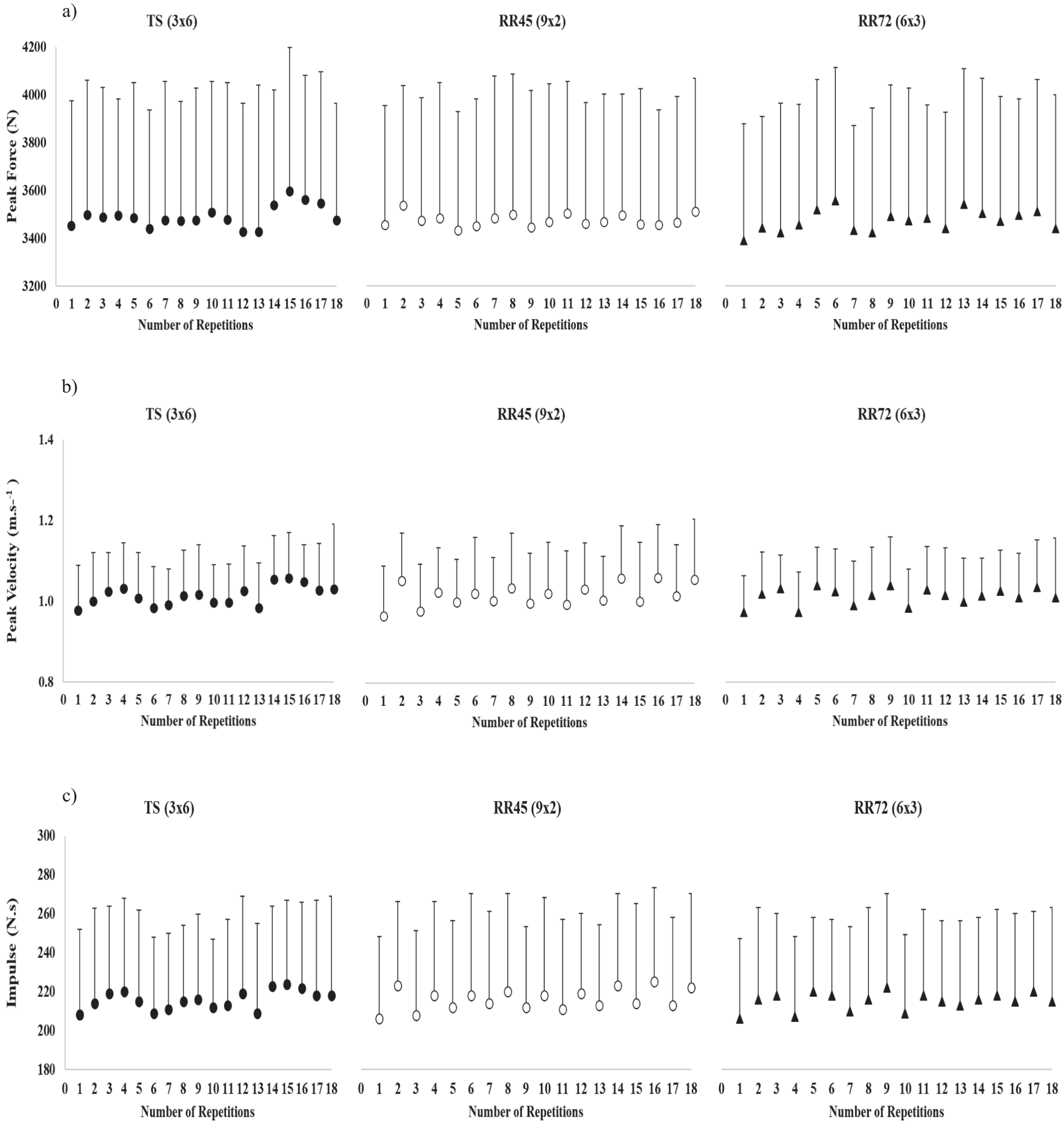

Figure 2a-c. Mean and standard deviation across 18 repetitions for the CMS at 140% 1RM PC for traditional sets (black circles), RR (open circles) with 45 s inter-repetition rest (RR45) and 72 s inter-repetition rest (black triangles) (RR72). No significant differences (p > 0.05) between protocols for the average of 18 repetitions.

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Discussion (Cont'd)

kinematics between the protocols, although the RR45 protocol reported the lowest RPE (Figure 3). Regardless of whether RR or TS configurations were performed, Jukic and Tufano (3) also showed that RPE increased across sets at all loads but demonstrated that RR was perceptually easier than TS, although previous authors have suggested that the number of repetitions in sequence may have an important role in RPE response (5). When averaged across the 18 repetitions, Jukic and Tufano (4) reported significantly lower RPE during RR protocols compared with TSs, which contrasts with this study. Other studies have also shown that set configurations with fewer repetitions per set result in lower RPE (3). The differences between this study and other studies may be a result of the different exercises performed, with the other studies performing lower intensities, but more importantly, exercises with a much greater movement displacement (i.e., clean pull from the floor) than the CMS.

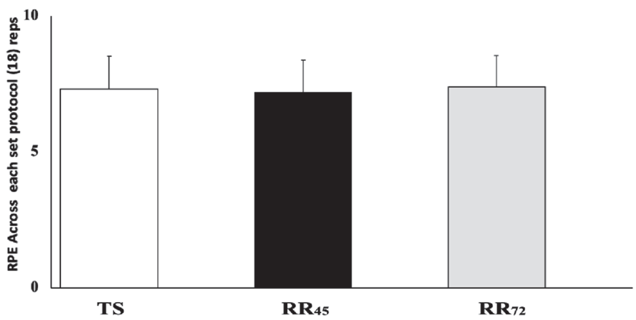

Figure 3. Rating of perceived exertion (RPE) for each set protocol across all repetitions. No significant differences ($p > 0.05$) between protocols for the average of 18 repetitions

This and previous studies calculated percentages based on the 1RM PC, which includes the catch phase (6) The CMS exercises theoretically have a greater 1RM based on the decreased displacement and range of motion (6).

Conclusion

The results demonstrated that the lack of meaningful differences in velocity and force (and likely power) may have been because of the lack of high levels of fatigue during TSs, potentially because of the minimal displacement during the CMS. If practitioners seek to implement RR protocols instead of TS configurations, this may only be beneficial if the TS configuration is highly fatiguing or when an exercise with a larger range of motion is performed.

Practical Applications

RR is not required during sets of six repetitions of CMS at 140% PC. However, having athletes perform RR protocols should allow practitioners to give more frequent technical feedback.

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Appendix 1. Sequence of Countermovement Shrug