RESEARCH HIGHLIGHTS

A Biomechanical Comparison of Mid-thigh Pull and Countermovement Shrug

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MARCH 2020

Introduction

Weightlifting exercises (snatch and clean and jerk) and their derivatives are commonly performed by athletes to develop rapid triple extension of the hips, knees and ankles (plantar flexion). These movements are required by a vast majority of sports [1,2] as they relate to both sprint and jump performance [3,4]. They are implemented due to the similarities in sport-specific movements (i.e. rapid extension of hips, knees and ankles) [5], whilst concurrently developing rapid force production and power. Research on weightlifting biomechanics has demonstrated that the second pull phase produces the greatest force and power applied to the barbell in experienced weightlifters during the power clean (PC) [6]. Recent research on weightlifting pulling derivatives (i.e. those that exclude the catch phase) indicates that such exercises may provide a greater [2,7] training stimulus than catch derivatives. Moreover, pulling derivatives permit supra-maximal loads [>100% 1 repetition maximum (RM) of a catching derivative] to be performed [8,9], which has shown to elicit greater peak force (PF), rate of force development and impulse (IMP) than loads less than 1RM PC [8,9]. This provides an overload stimulus of the triple extension movement, potentially producing superior strength–power characteristics [1,2]. It was hypothesised that the countermovement shrug (CMS) would result in higher values across all kinetic variables.

Methodology

This study used a within-subject repeated-measures research design, whereby kinetic variables [PF, peak power (PP) and net IMP] were determined during the mid-thigh pull (MTP) and CMS. Eighteen men (age = 29.43 ± 3.95 years, height = 1.77 ± 0.08 m, body mass = 84.65 ± 18.79 kg) completed a standardised warm-up, low-intensity cycling for 5 minutes, followed by one set of three repetitions at 40% 1RM PC and then three repetitions of the MTP and CMS on a force platform with 40%, 60%, 80%, 100%, 120% and 140% of 1RM PC with 30–60-s rest between repetitions and 3–4-min rest between loads. All subjects were instructed to exert maximal effort. Power was calculated by multiplying the vertical force and velocity at each time point. IMP 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 integrated force plate (400 Series) that sampled at 600 Hz and was interfaced with a desktop computer and ballistic measurement software.

Statistical Analyses

Two-way fixed-effect model intraclass correlation coefficients (ICC) and coefficients of variation were used to determine the reliability and variability of performance measures. 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 ≤ 0.05.

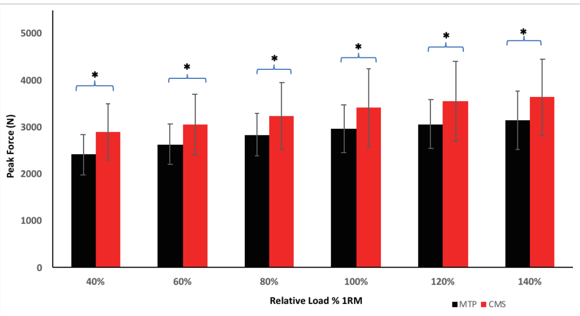

Figure 1. Comparision of PF.
* *denotes significant difference ($p < 0.001$, $g = 1.48–2.27$)*

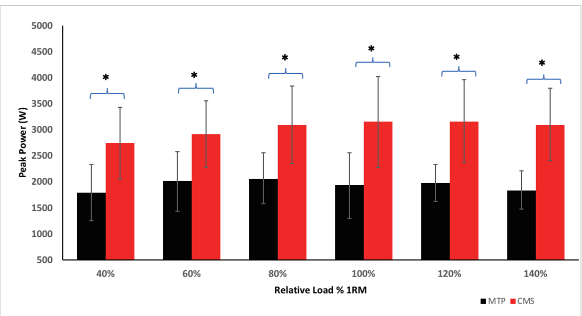

Figure 2. Comparision of PP.
* *denotes significant difference ($p \leq 0.001$, $g = 0.67–0.90$)*

Results

Reliability of all dependent variables was acceptable (ICC ≥ 0.75). The PF during the CMS was a moderately and significantly greater ($p < 0.001$, g = 1.48–2.27) than that during the MTP across all loads (Figure 1). There was a very large and significant difference in the PP during the CMS across all loads ($p \leq 0.001$, g = 0.67–0.90) (Figure 2). Net IMP during the CMS was significantly greater than that during the MTP across all loads ($p < 0.001$, g = 1.20–1.66) with a large magnitude (Figure 3).

Discussion

The results revealed that the inclusion of the CMS results in a large and significantly greater performance in all dependent variables when compared with the MTP, in line with our hypothesis. The PF reported in this study was lower than that reported in one study [8] but greater than that reported in another [9]. These differences may be the result of lifting competence and body mass differences, considering that the 1RM PC values were similar between the current and previous studies. The PP during the MTP was maximised at 80% 1RM. This is in contrast to that reported by Comfort et al. [8,9] who stated that the PP was maximised at 40% in both studies. Surprisingly, during the CMS, the PP was maximised at 120% 1RM, suggesting that higher loads are required to generate maximal power in the MTP and CMS. The finding that PP was maximised at different loads in both exercises is in agreement with the finding of Soriano et al. [10] who suggested that the optimal load for power development is exercise specific. Comfort et al. [8] demonstrated that although IMP was maximised at 140%, it was not significantly different from 80%–120%. IMP increased with load and was maximised at 120% 1RM. As IMP has been shown to have a perfect correlation to jump height and is strongly related to changes in direction and agility tasks, the use of the CMS may be preferred when the focus is improving the aforementioned athletic tasks, as greater IMP is achieved during the CMS than during the MTP at the same loads.

Limitation

This and previous studies calculated percentages based off the 1RM PC, which includes the catch phase [8,9]. The MTP and CMS exercises theoretically have a greater 1RM based on the decreased displacement and range of motion [1].

Conclusion

The stimulation of the SSC during the CMS results in a greater PF, PP and IMP compared with that during the MTP at all loads.

Practical Application

To maximise the PF, PP and IMP, the CMS may be preferable to the MTP.

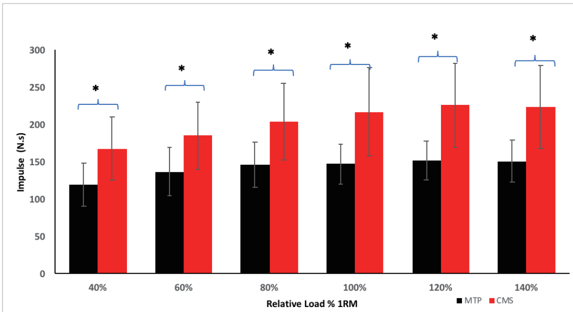

Figure 3. Comparision of IMP between the CMS and MTP across loads.
* *denotes significant difference ($p < 0.001$, $g = 1.20–1.66$)*

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MARCH 2020

Sequence of Mid-thigh Pull and Countermovement Shrug

Appendix 1. Sequence of Mid-thigh Pull

Appendix 2. Sequence of Countermovement Shrug