HOOK-GRIP IMPROVES POWER CLEAN KINETICS AND KINEMATICS

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The purpose of this study was to compare one repetition maximum (1RM), as well as biomechanical outputs across a range of loads (75-100%) in the power clean (PC) utilizing the hook grip (HG) or closed-grip (CG). Eleven well-trained males (PC 1RM=1.34xBW) with at least six months of HG experience volunteered. Following a familiarization session, PC 1RM testing with the HG and CG were completed in random order, 5-7 days apart on a force platform with linear position transducers and 2D motion capture. The HG condition resulted in greater PC 1RM (6.6%, ES=0.43), peak barbell velocity (2.9-5.2%, ES=0.41-0.70) and relative peak barbell power (5.7-15.1%, ES=0.32-0.71) at all submaximal loads compared to CG. No substantial differences were found in horizontal bar-path (ES=-0.27-0.32). The results of this study suggest that athletes who implement weightlifting movements in their physical preparation should adopt the HG.

KEYWORDS: Weightlifting, velocity, resistance training.

INTRODUCTION: Optimizing muscle power and rapid force production are important for performance in a variety of sports (Seitz, Reyes, Tran, de Villarreal, & Haff, 2014). Weightlifting movements such as the power clean mirror many athletic movements as they are ballistic and biomechanically similar to jumping, sprinting and change of direction tasks (Cormie, McGuigan, & Newton, 2010). Weightlifting movements and their variations are commonplace in strength and conditioning settings (Ebben, Carroll, & Simenz, 2004) as they are established for improving high velocity strength to a greater degree compared to traditional resistance training (Channell & Barfield, 2008).
Competitive weightlifters routinely utilize the hook-grip (HG) (Figure 1) when performing pulling actions (Tsuruda, 1989). Anecdotally, the HG prevents the barbell from rotating in the lifter's hand, thus enabling a secure grip (Tsuruda, 1989). Athletes and coaches report that a minimal amount of muscular effort is required to maintain a secure hold of the bar with a HG. By requiring less muscular tension in the finger flexors (Tsuruda, 1989), the arms remain passive, leading to a greater force transfer from the prime movers of the legs and back, facilitating greater force and power outputs (Tsuruda, 1989). This increased power output may benefit long-term athletic development (Channell & Barfield, 2008; Cormie et al., 2010; Hori et al., 2008). Therefore, the primary purpose of this study was to compare the kinetics and kinematics of the power clean with and without the HG. It was hypothesized that the HG would increase 1RM, and enable greater levels of force, velocity and power to be generated compared to a standard closed-grip (CG). It was also hypothesized that the HG would enable an optimized bar-path when compared to the CG condition.

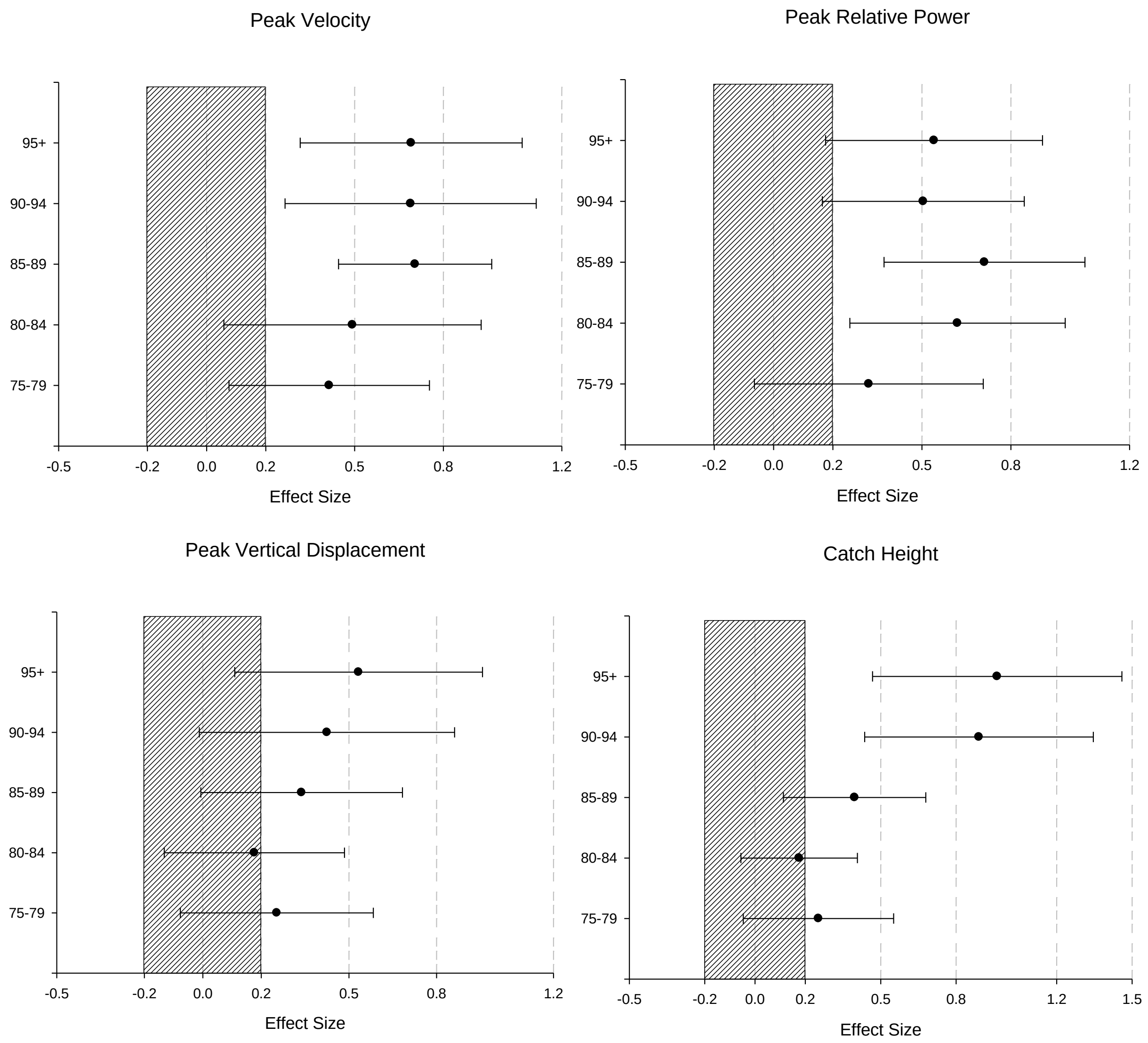
Figure 1. Hook-grip

METHODS: Eleven well-trained male strength and power athletes (reported PC 1RM=113.4±15.9 kg, age=28.1±5.6 years, height=176.2±6.4 cm, body mass=84.7±11.1 kg) volunteered. All testing procedures were completed across three laboratory visits, each separated by five to seven days. Following an initial CG 1RM familiarization session, all subjects completed PC 1RM testing sessions using CG and HG in random order. Each session was preceded by a standardized dynamic warm-up and followed a systematic sequence of increasing loads ranging from 50% to 100% of PC 1RM in 2.5-10% increments.
Kinetic and kinematic data were collected with a force plate (AMTI, Watertown, MA) sampling at 1000 Hz, and duel linear position transducer system (Fittech, Australia) sampling at 500 Hz interfaced with custom LabVIEW software (National Instruments, Austin, TX). Discribed in detail by Cormie, McBride and McCaulley (2007), the kinetic method was used to obtain peak and mean barbell velocity ($m \cdot s^{-1}$) and peak and mean barbell force (N) during the entire pull. Peak and mean barbell power was determined by multiplying force and velocity at each time point (Cormie, McBride, & McCaulley, 2007). A camera (Casio, EXLIM, EX-FH20, Tokyo, Japan) positioned 5 m from the end of the barbell and 65 cm above the platform, filmed at 300 fps to collect horizontal barbell displacement (Garhammer & Newton, 2013). A reflective marker, and a scaling rod were applied to the end of the barbell and platform respectively. Additional lighting was applied to the barbell with lamps placed behind the camera. Video footage was analyzed in Kinovea 0.8.15 motional analysis software to assess the four horizonal bar-path variables discribed in detail by Garhammer and Newton (2013).
Data were split into five categories to examine the effect of the HG at different defined relative intensities: 75-79%, 80-84%, 85-89, 90-94% and 95-100% of 1RM. Differences in the mean changes between the grips (CG and HG) were determined by paired samples t-tests. The precision of mean differences is expressed with 95% confidence limits (95%CL). The 95%CLs were constructed around the mean differences to express the range of uncertainty of the interval containing the true parameter value (or unknown population mean). Qualitative descriptors of standardized (Cohen's *d*) effect sizes were assessed using these criteria: trivial <0.2, small 0.2-0.49, moderate 0.5-0.79, large >0.8. Effects with 95%CLs overlapping the thresholds for small positive and small negative effects (i.e. exceeding 0.2 of the 95%CLs on both sides of zero) were defined as unclear. A clear effect size was defined as the mean of the 95%CL being ≥0.2 and not exceeding a trivial effect size on the other side of zero (Batterham & Hopkins, 2006). The reliability of all CG variables were assessed by typical error of measure (TEM) as $\Delta SD \div \sqrt{2}$.

RESULTS: Power clean 1RM was 6.8 kg greater when utilizing the HG (109.4±17.2 kg), compared to the CG (102.6±14.6 kg) (ES=0.43 95%CL [0.27-0.58]). The TEM of 1RM CG was 0.39 kg or 0.38%. Low TEMs were also found for all other reported variables (1.99-9.13%). No substantial between-condition differences were found for any horizontal bar-path variables (ES=-0.27-0.32). Descriptive statistics for the primary dependent variables are presented in Table 1. Differences between the primary dependent variables and each condition are presented in Figures 2-5.

Table 1. Descriptive data of dependent variables

Variable	Condition	75-79%		80-84%		85-89%		90-94%		95%+	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Peak Velocity ($m \cdot s^{-1}$)	Closed	2.10	0.13	2.01	0.12	1.92	0.12	1.85	0.12	1.83	0.12
	Hook	2.16	0.14	2.08	0.15	2.02	0.14	1.94	0.12	1.91	0.11
Peak Relative Power ($w \cdot kg^{-1}$)	Closed	34.64	5.72	33.47	5.86	33.55	6.95	33.93	6.46	33.53	6.13
	Hook	36.63	6.76	37.58	6.99	38.82	7.19	37.30	6.76	37.03	6.60
Peak Vertical Displacement (m)	Closed	1.08	0.06	1.05	0.05	1.03	0.05	1.00	0.04	0.99	0.04
	Hook	1.10	0.07	1.06	0.07	1.05	0.06	1.02	0.06	1.02	0.06
Catch Height (m)	Closed	1.01	0.08	0.97	0.08	0.92	0.10	0.82	0.11	0.81	0.11
	Hook	1.03	0.09	0.99	0.09	0.96	0.09	0.92	0.09	0.91	0.08



Figures 2-5. Forest plots illustrating effect sizes and 95%CL for each %1RM intensity bandwidth. The shaded region indicates trivial effect sizes.

DISCUSSION: The primary findings of this investigation confirmed the contentions of competitive weightlifters. The HG enabled substantially greater PC 1RM (6.64%, ES=0.43), improved peak velocity (2.9-5.2%, ES=0.41-0.70) and relative peak power (5.7-15.1%, ES=0.32-0.71) at all measured intensities. These data suggest implementing the HG leads to greater velocity and power in athletes who utilize weightlifting movements and their derivatives. The HG may allow athletes to utilize greater loads and express higher power in training which could enable greater overload and facilitate adaptations benefitting athletic performance (Cormie et al., 2010; Hori et al., 2008).

Peak vertical displacement and catch height where the participants secured the rack and ceased the downward movement of the barbell, provide interesting findings. Differences in peak vertical displacement between conditions were trivial to small (0.95-1.94%, ES=0.18-0.42) at any load below 95% of 1RM. These data show that the athletes were able to pull the barbell to similar heights regardless of the grip employed. Conversely, the HG enabled small to large improvements in catch heights at all loads above 84% (4.35-12.35%, ES=0.40-0.96). This relationship suggests that the HG is especially beneficial during the transition between the pull and catch phases of the PC at high relative loads, potentially by allowing the arms to remain relatively passive (Tsuruda, 1989). Additionally, peak velocity, a key determinant of weightlifting performance, was greater when using the HG across all intensities. This dichotomy between peak velocity and peak vertical displacement suggests that the

participants utilized different movement strategies to complete the PC depending on grip condition. Movement strategy distinctions would likely include alterations in impulse magnitude or the timing of force application (Suchomel & Sole, 2017). While it appears that grip is especially important in the transition between the pull and catch phases, practitioners who employ pulling derivatives should introduce their athletes to the HG. Additionally, the present data suggest that using barbell height to monitor progress and optimal loading in weightlifting derivatives may be inappropriate.
Limitations exist in the present study. Firstly, participants were required to have at least six months of experience with the HG to avoid inhibition due to initial discomfort. While there was no substantial change (-0.52%, ES=0.03) in 1RM reliability testing, suggesting no acute learning effect, the results could have been different in a population accustomed to performing the PC with a CG. Secondly, the present study only examined the PC. Other weightlifting movements or derivatives including the high-pull may be differently affected by grip choice. Finally, thumb pain is anecdotally reported during the initial adoption of HG. Thus, practitioners should provide a transitional period before expecting increased performance.

CONCLUSION: The HG enabled greater maximal loads to be lifted in the PC and also improved velocity and power output across a range of submaximal loads. It was also apparent that the ability to transition from the pull to the catch phases of the PC was enhanced in the HG condition at near maximal loads. Interestingly, there was not a clear difference in peak vertical displacement of the barbell between conditions at submaximal intensities. Therefore, future research comparing grips in weightlifting movements should examine force-time curves (Suchomel & Sole, 2017) and include joint level kinematics (Kipp et al., 2018) to elucidate any further differences in movement strategies. Additionally, researchers should control and report the type of grip used in studies examining weightlifting movements and their derivatives. The examination of lifting straps and other grip tools may also be of interest.

REFERENCES:

Batterham, A. M., & Hopkins, W. G. (2006). Making meaningful inferences about magnitudes. *International Journal of Sports Physiology and Performance, 1*(1), 50-57.

Channell, B. T., & Barfield, J. P. (2008). Effect of Olympic and traditional resistance training on vertical jump improvement in high school boys. *Journal of Strength and Conditioning Research, 22*, 1522-1527.

Cormie, P., McBride, J. M., & McCaulley, G. O. (2007). Validation of power measurement techniques in dynamic lower body resistance exercises. *Journal of Applied Biomechanics, 23*(2), 103-118.

Cormie, P., McGuigan, M. R., & Newton, R. U. (2010). Adaptations in athletic performance after ballistic power versus strength training. *Medicine and Science in Sports and Exercise, 42*, 1582-1598.

Ebben, W. P., Carroll, R. M., & Simenz, C. J. (2004). Strength and conditioning practices of National Hockey League strength and conditioning coaches. *Journal of Strength and Conditioning Research, 18*, 889-897.

Garhammer, J., & Newton, H. (2013). Applied video analysis for coaches: Weightlifting examples. *International Journal of Sports Science and Coaching, 8*(3), 581-594.

Hori, N., Newton, R. U., Andrews, W. A., Kawamori, N., McGuigan, M. R., & Nosaka, K. (2008). Does performance of hang power clean differentiate performance of jumping, sprinting, and changing of direction? *Journal of Strength and Conditioning Research, 22*(2), 412-418.

Kipp, K., Malloy, P., Smith, J. C., Giordanelli, M., Kiely, M., Geiser, C. F., & Suchomel, T. J. (2018). Mechanical demands of the hang power clean and jump shrug: A joint-level perspective. *Journal of Strength and Conditioning Research, 32*(2), 466-474.

Seitz, L. B., Reyes, A., Tran, T. T., de Villarreal, E., & Haff, G. G. (2014). Increases in lowerbody strength transfer positively to sprint performance: A systematic review with meta-analysis. *Sports Medicine, 44*, 1693-1702.

Suchomel, T. J., & Sole, C. J. (2017). Force-time-curve comparison between weight-lifting derivatives. *International Journal of Sports Physiology and Performance, 12*(4), 431-439. Tsuruda, C. I. (1989). The hook grip. *National Strength and Conditioning Association Journal, 11*(2), 40-41.