KINEMATIC AND KINETIC FEATURES OF THE HORIZONTAL HANG CLEAN PERFORMED WITH A VARIETY OF LOADS

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INTRODUCTION

Power exercises categorized by vertical (V) displacement have little correlation to sprinting speed (Rumpf et al., 2012; Young et al., 2015). Research assessing the ground reaction forces (GRF) of the power clean focused on V mechanics (Jensen & Ebben, 2002), or horizontal (H) displacement of barbell, but not the subject (Comfort et al., 2011; Souza et al., 2002). Exercises that offer resistance along with H displacement of the athlete are most valuable for developing sprinting ability (Rumpf et al., 2012; Young et al., 2015).

The horizontal hang clean (H-HC) is a variation of the traditional hang clean where the subject produces a higher H-GRF to V-GRF ratio (H:V) (Gold et al., 2020). Compared to the traditional hang clean, the H:V of the H-HC is more similar to the H:V of sprinting (Gold et al., 2020). Therefore, the H-HC should be used to increase the transfer of training to activities such as sprinting. However, it is not known if there is an exercise intensity for the H-HC that optimizes training specificity. Therefore, this study assessed a variety of H-HC loading conditions to determine the relationship between H:V, H-GRF, V-GRF, H displacement and velocity of the subject, and the relationship of these loading conditions to the standing sprint start (SSS).

METHODS

Subjects included 12 men (age = 19.67 ± 0.89 years) who provided written informed consent for the study which was approved by the IRB.

During testing, subjects performed the H-HC and the SSS on two flush to the floor mounted force platforms (Accupower, Advanced Mechanical Technology, Inc., Watertown, MA, USA) deployed in series (Figure 1). Subjects performed the H-HC at 30% (H-HC 30) 50% (H-HC 50), and 70% (H-HC 70) of their estimated five repetition maximum load for the traditional hang clean.

The peak V-GRF and H-GRF were obtained. Additionally, H displacement was determined using center of pressure (COP) measurements from the propulsive and landing phase of the H-HC. Kinematic variables such as subject H anterior displacement and velocity were derived from the COP data.

Data were analyzed with SPSS 27.0 using an ANOVA with repeated measure for exercise type as a between-subject's factor. Bonferroni adjusted pairwise comparisons were used to identify specific differences in H-GRF, V-GRF, H:V, time to stabilization (TTS), displacement, and velocity between the H-HC conditions. Pearson's correlation coefficients were used to assess the relationship between the H-HC H:V and subject H displacement during H-HC, and the relationship between the kinetic characteristics of the H-HC and SSS. The trial-to-trial reliability of each dependent variable was assessed using average measures Intraclass correlation coefficients and analysis of variance for each of the dependent variables.

Figure 1. Starting and landing position (catch phase) of the H-HC 30.

RESULTS

Analysis of the kinetic variables for the H-HC conditions revealed significant main effects for the propulsive phase V-GRF (p = 0.001, d = 1.00, η_p^2 = 0.74) and H:V (p = 0.001, d = 0.99, η_p^2 = 0.54). There was no significant differences between H-HC conditions for landing phase H-GRF or V-GRF or H:V (p > 0.05). Analysis of the TTS yielded no significant differences (p = 0.38) between H-HC conditions. Data are shown in Table 1.

Analysis of the kinematic variables revealed significant differences between the H-HC conditions for subject/barbell displacement ($p \leq 0.001$, d = 1.00, η_p^2 = 0.60) and velocity ($p \leq 0.001$, d = 0.79, η_p^2 = 0.33), as shown in Table 2.

The H:V of the first step of the sprint was correlated to the H:V of the H-HC 30 (p = 0.04, r = 0.55) but not the H:V of the H-HC 50 or H-HC 70 (p > 0. 05). The H:V of the second step of the sprint was correlated to the H:V of the HH-C 30 H:V (p = 0.03, r = 0.63) but not for the H:V of the H-HC 50 or H-HC 70 (p > 0. 05). The H:V of all H-HC test conditions were correlated with each other ($p \leq$ 0.01, r > 0.70). Interclass correlation coefficients were calculated for all dependent variables, with all values ranging between 0.82 and 0.99 (all p values > 0.05).

Table 1. Comparison of the kinetics of the propulsive and landing phases between the three H-HC conditions (N = 12).

	H-HC 30	H-HC 50	H-HC 70
Propulsive H-GRF (N)	383.68 ± 91.94	376.16 ± 64.48	379.99 ± 51.98
Propulsive V-GRF (N)[a]	1924.67 ± 301.80	2108.59 ± 340.65	2376.83 ± 313.69
Propulsive H:V[b]	0.20 ± 0.04	0.18 ± 0.03	0.16 ± 0.02
Landing H-GRF (N)	438.61 ± 97.41	406.42 ± 134.39	393.25 ± 170.92
Landing V-GRF (N)	1656.29 ± 292.54	1655.71 ± 278.17	1748.58 ± 300.55
Landing H:V	0.27 ± 0.08	0.25 ± 0.09	0.23 ± 0.10
TTS (seconds)	1.66 ± 0.52	1.76 ± 0.77	1.90 ± 0.54

Table 2. Comparison of displacement and velocity between the three H-HC conditions (N = 12).

	HHC 30	HHC 50	HHC 70
Displacement (m)[a]	1.24 ± 0.23	1.03 ± 0.23	0.90 ± 0.21
Velocity ($m \cdot s^{-1}$)[b]	2.05 ± 0.78	1.82 ± 0.61	1.70 ± 0.62

DISCUSSION/CONCLUSION

This is the first study to show that there are significant differences in H-HC V-GRF, H:V, displacement, and subject velocity based on exercise load.

Performing the H-HC 30 was superior to the higher load conditions for most of these variables. Previous research assessed the conventional hang clean and focused on V-GRF (Comfort et al., 2011; Souza et al., 2002). However, V oriented exercises have limited transfer of training to sprinting (Young et al., 2015). As a result, whole body H oriented exercises have been recommended (Young et al., 2015) and exercises such as the H-HC have been investigated, demonstrating kinetics more similar to sprinting than the traditional hang clean (Gold et al., 2020).

Results of the present study revealed a H:V of .20 for the H-HC 30 condition. Previous research demonstrated H:V in a range of .20 to .29 for a variety of H oriented plyometric (Duffin et al., 2019). Thus, the H-HC 30 in the present study is similar to that of some H plyometrics. The traditional hang clean yielded a H:V of .09 (Gold et al., 2020).

In the present study, the H:V of the H-HC 30 was correlated with the sprint start H:V. The H:V of sprinting in the present study was .41. This result is similar to previous findings of .36 to .40 (Duffin et al., 2019).

In the present study subject velocity and displacement was highest in the 30% load condition, with H displacement 98.39% larger than the traditional hang clean (Gold et al., 2020). The H-HC displacement is correlated with the H:V at the start of sprinting (Gold et al., 2020). Results of this study are consistent with research demonstrating that V-GRF of the hang clean and hang snatch were higher as a function of increasing loads (Jensen & Ebben, 2002). Landing kinetics of the present study were not significantly different between conditions. While the velocity and H displacement may make the landings phase of the H-HC feel uniquely challenging, it is no more kinetically intense than the landing phase of a variety of H plyometrics (Kossow & Ebben, 2018). However, in the present study, the TTS during all conditions of the H-HC ranged from 1.66 to 1.90 seconds. These values are much higher than the TTS of several plyometrics exercises, where values range from 0.50 to 0.99 seconds (Ebben, et al., 2010). Thus, the H-HC presents a greater instability training stimulus upon landing.

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