KINETIC ANALYSIS OF THE TRADITIONAL AND HORIZONTAL HANG CLEAN

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INTRODUCTION

The hang clean is a common weightlifting exercise used to train athletes. The kinetics of the hang clean and other weightlifting variations have frequently been evaluated. However, training with the traditional hang clean (T-HC) may be sub-optimal for more horizontally based activities such as sprinting.

The kinetic variables of the T-HC have been assessed during a variety of loading conditions (Suchomel, Beckham & Wright, 2014). The T-HC has also been compared to other related exercises such as the hang snatch, with the assessment of the exercise intensity on ground reaction forces (GRF) and impulse (Jensen & Ebben, 2002).

Training with exercises offering resistance along with concomitant horizontal displacement of the subject and/or added training load may be most valuable for developing sprinting ability (Young et al., 2015). Most research focused on the vertical mechanics (Comfort, Allen & Graham-Smith, 2011; Souza, Shimada & Koontz, 2002), or the horizontal displacement of the barbell during weightlifting variations, but not subject displacement (Petrizzo et al., 2016). Resistance training should include the development of horizontal GRF as well, in order to maximize the transfer of training (Mero & Komi, 1994; Randell et al., 2010).

Therefore, the purpose of this study was to introduce the horizontal hang clean (H-HC) and compare it's horizontal to vertical ground reaction force ratio (H:V) to that of the traditional hang clean (T-HC). These H:V were also compared to the H:V associated with jumping and sprinting. This study also assessed sex-based differences therein.

METHODS

Subjects included ten men (age = 20.7 ± 1.42 yr) and ten women (age = 21.1 ± 2.42 yr). Subjects provided written informed consent and the study was approved by the institution's Internal Review Board.

Subjects were tested on a force platform in the following randomized conditions including the T-HC, H-HC, standing sprint start (SSS), and the countermovement jump (CMJ). The T-HC and H-HC test sets were performed with 70% of the subject's five repetition maximum T-HC load. Two sets of one repetition each were be performed for the T-HC and H-HC test sets as well as the SSS and CMJ.

The peak GRF for each test was obtained from a flush to the floor-mounted force platform (Accupower, Advanced Mechanical Technology, Inc., Watertown, MA, USA). Horizontal displacement was determined for the T-HC and H-HC. Data were analyzed with a statistical software program (SPSS 26.0, International Business Machines Corporation, Armonk, New York) using an ANOVA with repeated measure for exercise type and gender as a between subjects factor. Bonferroni adjusted pairwise comparisons were used to identify specific differences in H:V, horizontal GRF, and vertical GRF between the exercise types. Pearson's correlation coefficients were used to assess the relationship between the H-HC H:V and subject horizontal displacement during H-HC, and the relationship between the kinetic characteristics of the H-HC, T-HC, SSS, and CMJ. 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. Assumptions for linearity of statistics were tested and met. Statistical power (d) and effect size (η_p^2) are reported and all data are expressed as means ± SD. The a priori alpha level was set at $p \leq 0.05$.

RESULTS

Results revealed main effects for horizontal GRF ($p \leq 0.001$, $d = 1.00$, $\eta_p^2 = 0.73$), vertical GRF ($p \leq 0.001$, $d = 1.00$, $\eta_p^2 = 0.84$), and H:V ($p \leq 0.001$, $d = 1.00$, $\eta_p^2 = 0.83$). There was no interaction between any of these variables and gender ($p > 0.05$). Figures 1-3 show the horizontal GRF, vertical GRF, and the H:V for each test condition, and the results of the Bonferroni post-hoc analysis. Mean horizontal displacement for the T-HC and H-HC was 2.33 ± 7.24 cm and 71.05 ± 14.52 CM, respectively, resulting in a 96.7% difference between the hang clean variations ($p \leq 0.001$). Pearson's correlation coefficients demonstrate that H-HC H:V is correlated with subject horizontal displacement during H-HC (r = .58, p = 0.007). The H-HC horizontal displacement is correlated SS H:V ratio (r = .50, p = 0.026). The H-HC vertical GRF was correlated to the SSS vertical GRF (r = .73, p = 0.001). The H-HC horizontal GRF and vertical GRF are correlated with CMJ horizontal GRF (r = .66, p = 0.022) and vertical GRF (r= .53, p = 0.017), respectively. The H-HC vertical GRF is correlated with CMJ vertical GRF (r = .70, p = 0.001). The T-HC horizontal GRF and vertical GRF were correlated with CMJ horizontal GRF (r = .48, p = 0.031) and vertical GRF (r = .58, p = 0.008), respectively. Interclass correlation coefficients were calculated for all dependent variables, with all values ranging between 0.84 and 0.99 (all p values > 0.05).

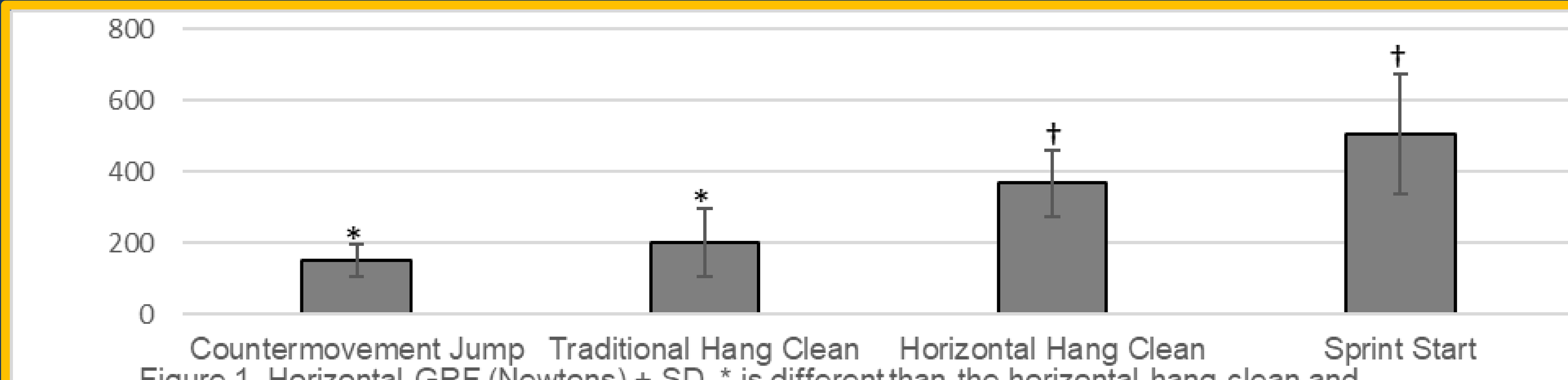

Figure 1. Horizontal GRF (Newtons) ± SD. * is different than the horizontal hang clean and sprint start. † is different than all other exercise conditions.

Figure 2. Vertical GRF in Newtons ± SD. * is different than the sprint start and the countermovemnt jump. † is different than all other exercise conditions.

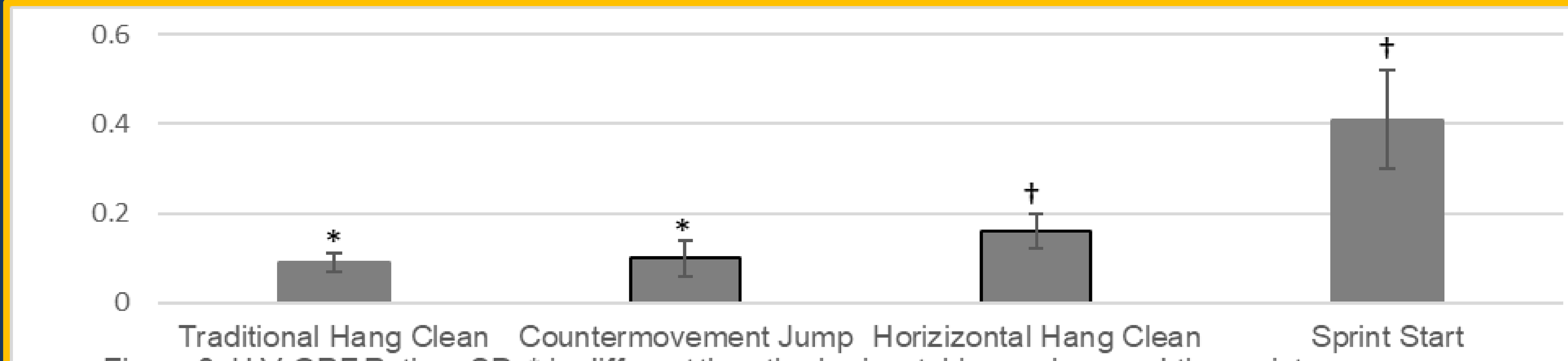

Figure 3. H:V GRF Ratio ± SD. * is different than the horizontal hang clean and the sprint start. † is different than all other exercies.

DISCUSSION/CONCLUSION

This study introduces the H-HC and compared it to the T-HC. The H:V of the H-HC is significantly greater than that of the T-HC, and more closely approximates the H:V of the SSS. Compared to the H:V of T-HC, the H:V of the H-HC was more similar to the H:V of sprinting starts (Duffin, Stockero & Ebben, 2019; Mero & Komi, 1994) and horizontally oriented plyometric exercises (Duffin, Stockero & Ebben, 2019). The current study also shows that subject's horizontal displacement during the H-HC was correlated with their H-HC H:V, which was correlated with their SSS H:V. Sprint training should focus on the development of horizontal force (Randell et al., 2010). Most studies assessed the vertical GRF associated with the T-HC (Comfort, Allen & Graham-Smith, 2011; Souza, Shimada & Koontz, 2002).

In the current study, the H-HC produced greater horizontal GRF and greater mean vertical GRF compared to the T-HC. In fact, the H-HC produced more horizontal GRF than horizontally oriented plyometric exercises such as skipping, bounding, and long jumps (Kossow & Ebben, 2018). The T-HC in the current study produced a H:V that was similar to the CMJ. Thus, the vertically oriented T-HC is more sport specific to jumping.

No sex-based difference were found in this study consistent with previous research assessing horizontal or vertical plane for plyometric exercises (Kossow & Ebben, 2018). Practitioners and athletes should use the H-HC as part of their training in order to optimize the acute training stimulus in both the horizontal and vertical planes, and to increase the likelihood of transfer of training to horizontal athletic activity such as sprinting. Men and women are likely to respond similarly to this type of training.

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