Short Communication

Lower body kinetics during the jump shrug: impact of load

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Objectives: To examine the impact of load on lower body kinetics during the jump shrug.
Design: Randomized, repeated measures design.
Methods: Fourteen men performed randomized sets of the jump shrug at relative loads of 30%, 45%, 65%, and 80% of their one repetition maximum hang clean (1RM-HC). A number of variables were obtained through analysis of the force-time data, which included peak force, peak velocity, peak power, force at peak power, and velocity at peak power. A series of one-way repeated measures ANOVA were used to compare the differences in peak force, peak velocity, peak power, force at peak power, and velocity at peak power between each load.
Results: Statistical differences in peak velocity, peak power, force at peak power, and velocity at peak power existed between loads ($p<0.001$), while peak force trended toward statistical significance ($p=0.060$). The greatest peak velocity, peak power, and velocity at peak power occurred at 30% 1RM-HC. In addition the greatest peak force and force at peak power occurred at loads of 65% and 80% 1RM-HC, respectively.
Conclusions: Velocity is the greatest contributing factor to peak power production during the jump shrug. Practitioners should prescribe specific loading schemes for the jump shrug to provide optimal training stimuli to their athletes based on the training goal: specifically, loads of 65% 1RM-HC or higher, loads of approximately 30-45% 1RM-HC, and loads of 30% 1RM-HC should be prescribed for improvements in peak force and force at peak power, peak power, and velocity and velocity at peak power, respectively.

(***Journal of Trainology*** **2013;2:19-22)**

Key words: lower body power ■ power training ■ power clean variations ■ optimal load ■ explosiveness

Introduction

The jump shrug (JS) is a weightlifting variation that can be used to teach the power clean (PC), but can also be used to train lower body power itself.[1] The JS is ballistic in nature and requires a subject to perform a countermovement with the barbell to the top of the knee, return to the mid-thigh position, and maximally jump while simultaneously shrugging their shoulders.[1-3] This PC variation differs from others in that there is a deliberate attempt to jump with the barbell. Despite its potential to produce high amounts of lower body power, only one study has investigated the power development potential of the JS. Suchomel et al.[1] demonstrated that the JS produced statistically greater peak force (PF), velocity (PV) and power (PP) than the hang clean (HC) when performed at the same absolute loads. However, their study only examined main effect differences and did not examine the impact that load had on the kinetics associated with power development during the JS.

Much of the research that has examined PC variations has attempted to identify the optimal load for the greatest production of PP.[4-9] However, all of this research has examined either the PC from the floor[4-6,9] or the HC[7,8] whereas no research has examined the optimal load of the JS. Although not the main purpose of the study, Suchomel et al.[1] indicated that the greatest PP for the JS occurred at 30% one repetition maximum HC (1RM-HC). However, as previously mentioned, their study did not examine the differences in PP between loads. Thus, little is known about how the load impacts lower body kinetics associated with PP production during the JS. Because PC variations appear to be important to many strength and conditioning training programs,[6,9,10] there is a need to examine the impact that load has on lower body power kinetics during individual PC variations. Therefore, the purpose of this study is to examine the impact of load on the lower body kinetics of the JS. It is hypothesized that the greatest PF, PV, and PP during the JS will occur at 65%, 30%, and 30% 1RM-HC, respectively, and that each lower body performance variable will display statistical differences between loads.

Methods

Subjects

Fourteen males (age:21.64±1.28yr, height:179.30±5.56cm, body mass:81.48±8.73kg, 1RM-HC:104.89±15.07kg) volunteered for this investigation. Each subject had at least two years of previous training experience with the HC, but no previous competitive lifting experience. All subjects read and signed University Institutional Review Board approved

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Received August 21, 2013; accepted September 25, 2013

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Communicated by Takashi Abe, PhD

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Journal of Trainology **2013:2:19-22** **http://trainology.org/**

informed consent documents.

Instrumentation and Data Collection Procedures

Subjects completed a familiarization and testing session. The familiarization session was used to determine the subject's 1RM-HC and to familiarize the subjects with the JS. Following a standardized warm-up (e.g. light cycling, lunges, countermovement jumps, etc.), subjects completed submaximal HC sets at approximately 30%, 50%, 70%, and 90% of their self-assessed 1RM-HC.[11] Subjects were given two attempts at each increased load until their 1RM-HC was established. All repetitions were completed using the HC technique previously described by Kawamori et al.[7] A 1RM-HC was completed because it may be impractical to perform at 1RM-JS test. Following the 1RM-HC test, subjects were familiarized with the technique of the JS by performing light exercise sets with 30% of their 1RM-HC. Briefly, the JS required the subject to start in a standing position and perform the same countermovement that was performed during the HC. Following the countermovement, the JS required the subject to maximally jump with the barbell while simultaneously shrugging their shoulders.[1-3]

Subjects returned for their testing session 2-7 days later. Prior to testing repetitions, subjects performed the same dynamic warm-up described above followed by submaximal exercise sets of the JS (e.g. 30%, 50% 1RM-HC). Subjects then completed three, single maximal effort repetitions each of the JS at relative loads of 30%, 45%, 65%, and 80% of their 1RM-HC in a randomized order totaling 12 repetitions. The order of loads was randomized to eliminate any potentiating or fatiguing effects. One minute of recovery was provided between repetitions[10] and two minutes of rest were provided between each load. The barbell was placed on the safety bars of a squat rack between repetitions to minimize fatigue. Subjects were encouraged to perform all repetitions with maximal effort.

All JS repetitions were performed on a Kistler Quattro Jump force platform (Type 9290AD, Kistler, Winterthur, Switzerland) interfaced with a computer and were sampled at 500Hz. Vertical ground reaction forces of the lifter-plus-bar system were measured directly with the force platform and the force-time data was exported into a template created in Microsoft Excel (Microsoft Corporation, Redmond, VA). Velocity of the lifter-plus-bar system was then calculated using the impulse-momentum relationship as detailed by Hori et al.[12,13] Power of the lifter-plus-bar system was equal to the product of the force and velocity. Finally, the force and velocity that were present at the time of PP production were used as the values of force at peak power (F_{PP}) and velocity at peak power (V_{PP}). The greatest PF, PV, PP, F_{PP}, and V_{PP} values produced at each load were used for comparison.

Statistical Analyses

A series of one-way repeated measures ANOVA were used to compare the differences in PF, PV, PP, F_{PP}, and V_{PP} within the JS at various loads (30%, 45%, 65%, 80% 1RM-HC). When necessary, the Bonferroni technique was used for post hoc analysis. All statistical analyses were performed using SPSS 21 (IBM, New York, NY) and statistical significance was set at $p<0.05$. Intraclass correlation coefficients were used

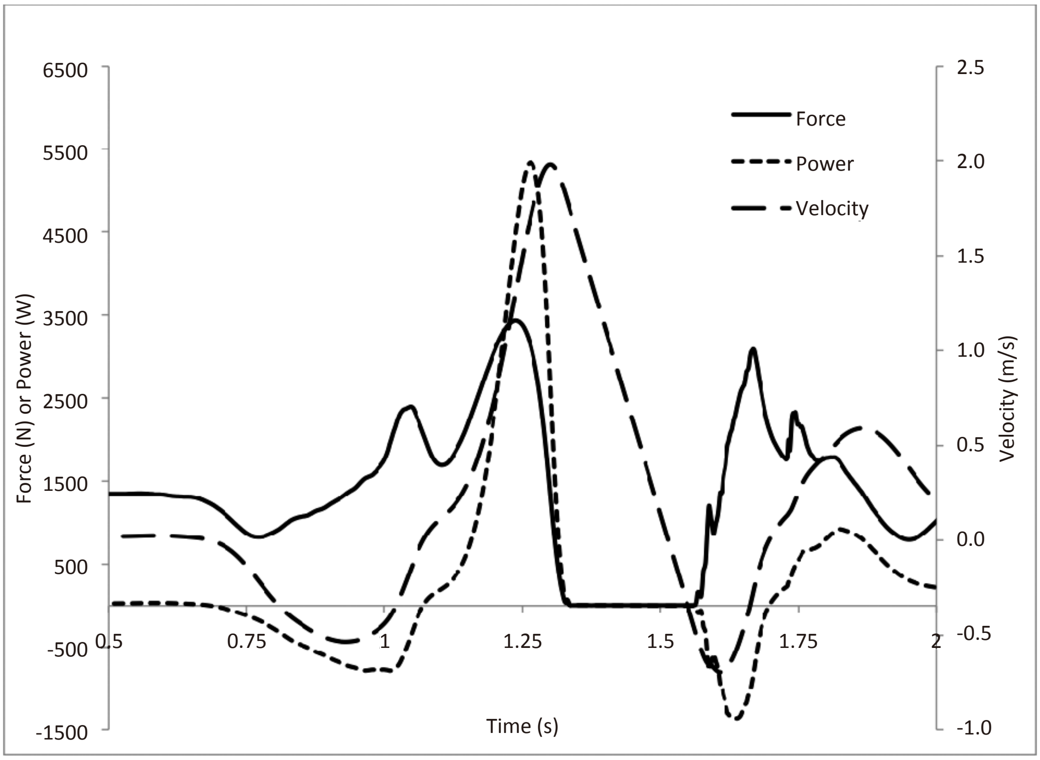

Figure 1 Example of force-, velocity-, and power-time curves during the jump shrug.

to assess internal consistency of each variable and are displayed in Table 1. Effect sizes were calculated using Cohen's *d* and were interpreted using the scale developed by Hopkins.[14] Statistical power was calculated for all measures and ranged from 0.52–1.00. Finally, 95% confidence intervals were calculated for all statistical measures.

Table 1 Intraclass correlation coefficient (ICC) ranges of each performance variable: n = 14.

Variable	ICC Range
Force	0.98 – 0.99
Velocity	0.72 – 0.89
Power	0.91 – 0.94
Force at Peak Power	0.98 – 0.99
Velocity at Peak Power	0.72 – 0.90

Notes: The ICC ranges represent the ICC values that occurred at each load for each variable.

Results

The PF, PV, PP, FPP, and VPP data are displayed in Table 2. The current study yielded statistical differences in PV ($F_{3,39}$=65.274, *p*<0.001), PP ($F_{3,39}$=17.938, *p*<0.001), FPP ($F_{1.72,22.37}$=14.853, *p*<0.001), and VPP ($F_{3,39}$=46.828, *p*<0.001) between the loads examined. However, no statistical difference in PF existed ($F_{1.45,18.80}$=3.601, *p*=0.060). The PV at 30% 1RM-HC was statistically greater than the PV at 45% (*p*=0.030, *d*=1.17, CI=0.01–0.33), 65% (*p*<0.001, *d*=2.94, CI=0.34–0.60), and 80% 1RM-HC (*p*<0.001, *d*=4.19, CI=0.49–0.80). In addition, the PV at 45% 1RM-HC was statistically greater than the PV at 65% (*p*=0.002, *d*=2.06, CI=0.11–0.49) and 80% 1RM-HC (*p*<0.001, *d*=3.42, CI=0.32–0.62). Finally, the PV at 65% 1RM-HC was statistically greater than the PV at 80% 1RM-HC (*p*=0.028, *d*=1.16, CI=0.02–0.33). The PP at 30% 1RM-HC was statistically greater than the PP that occurred at 65% (*p*=0.005, *d*=0.97, CI=184.30–1167.39) and 80% 1RM-HC (*p*<0.001, *d*=1.33, CI=534.90–1560.69). In addition, the PP at 45% 1RM-HC was statistically greater than the PP at 80% 1RM-HC (*p*<0.001, *d*=1.21, CI=434.27–1391.50). The FPP at 30% 1RM-HC was statistically lower than the FPP at 45% (*p*=0.008, *d*=0.25, CI=21.27–156.93), 65% (*p*<0.001, *d*=0.48, CI=86.11–263.44), and 80% 1RM-HC (*p*=0.010, *d*=0.46, CI=35.04–296.79). The VPP at 30% 1RM-HC was statistically greater than the VPP at 65% (*p*<0.001, *d*=2.46, CI=0.25–0.48) and 80% 1RM-HC (*p*<0.001, *d*=3.26, CI=0.34–0.63). In addition, the VPP at 45% 1RM-HC was statistically greater than the VPP at 65% (*p*=0.005, *d*=1.84, CI=0.07–0.41) and 80% 1RM-HC (*p*<0.001, *d*=2.76, CI=0.23–0.50). No other statistical differences existed (*p*>0.05)

Discussion

The current study examined the impact of load on the lower body kinetics associated with PP during the JS. The main findings of this study were that the PV and PP of the JS both occurred at 30% 1RM-HC and statistical differences in PV, PP, FPP, and VPP existed between loads during the JS. However, no statistical difference in PF existed between loads. Therefore, our hypotheses were partially supported as the PV and PP of the JS both occurred at 30% 1RM-HC and differences in PV, PP, FPP, and VPP existed between loads.

Despite a trend toward statistical significance, no statistical differences in PF between loads were present. It was interesting that the highest PF value occurred at 65% 1RM-HC instead of 80% 1RM-HC. This finding is in contrast to previous research that indicated that PF increases in parallel with an increasing load.[7,8] However, it is possible that the decrease in PF at higher loads during the JS can be attributed to the breakdown of technique. It is possible that if the subjects had more training experience with the JS that their technique would remain unaffected at higher loads.

As expected, the lowest load (30% 1RM-HC), produced the greatest PV. Furthermore, the PV at 30% 1RM-HC was 5.9%, 20.6%, and 29.4% greater than the PV at 45%, 65%, and 80% 1RM-HC, respectively, with all of these differences resulting in statistical significance. If practitioners are seeking to improve the velocity of a loaded triple extension movement, it appears that practitioners should prescribe loads at approximately 30% 1RM-HC.

Several studies have attempted to identify the optimal load

Table 2 The impact of load on jump shrug performance variables (mean ± SD): n = 14.

Load (% 1RM-HC)	**Performance Variable**				
	PF (N)	PV (m/s)	PP (W)	FPP (N)	VPP (m/s)
30%	3271 ± 389	2.44 ± 0.16	5823 ± 770	2899 ± 373	2.06 ± 0.16
45%	3399 ± 471	2.27 ± 0.13[a]	5688 ± 706	2985 ± 365[b]	1.93 ± 0.12
65%	3440 ± 450	1.97 ± 0.16[c,d]	5147 ± 623[b]	3074 ± 356[c,d]	1.69 ± 0.14[c,d]
80%	3402 ± 540	1.79 ± 0.15[c,e,f]	4775 ± 802[c,e]	3065 ± 351[a]	1.57 ± 0.14[c,e]

Notes: PF, peak force; PV, peak velocity; PP, peak power; FPP, force at peak power; VPP, velocity at peak power; [a], statistically different from value at 30% 1RM-HC (*p* < 0.05); [b], statistically different from value at 30% 1RM-HC (*p* < 0.01); [c], statistically different from value at 30% 1RM-HC (*p* < 0.001); [d], statistically different from value at 45% 1RM-HC (*p* < 0.01); [e], statistically different from value at 45% 1RM-HC (*p* < 0.001); [f], statistically different from value at 65% 1RM-HC (*p* < 0.05) for PP production during PC and its variations.[4-9] However, this research has only examined either the PC from the floor[4-6,9] or the HC.[7,8] In line with previous research[1], the current study demonstrated that the load that produced the greatest PP for the JS was 30% 1RM-HC. However, PP at 30% 1RM-HC was not statistically different from PP at 45% 1RM-HC. From a practical standpoint, it appears that loads ranging from 30-45% 1RM-HC should be prescribed to provide the optimal PP stimulus to athletes when using the JS. However, if the HC is not typically prescribed, an alternative method for prescribing loads to provide an optimal lower body power stimulus would be prescribing loads relative to the body mass of the athletes, assuming that the athletes have a similar training status and are familiar with the JS and other PC variations. In the current study, the loads of 30% and 45% 1RM-HC corresponded to approximately 39% and 58% of the body masses of the subjects, respectively. Because limited research exists on the optimal load of the JS, additional research is needed on this topic.

This was the first study that compared F_{PP} and V_{PP} at different loads during the JS. By analyzing F_{PP} and V_{PP}, it is possible to provide insight on the contributing factors of PP. Although statistical differences in F_{PP} existed, the range of F_{PP} values was small (175 Newtons), suggesting that the load did not affect F_{PP} much. Small effect sizes between loads illustrate this point. As expected, V_{PP} decreased as the external load increased. In contrast to F_{PP}, large or very large effect sizes existed between loads, suggesting that the external load affected V_{PP} a great extent. Collectively, these results indicate that velocity is likely the primary contributor to PP during the JS. It is suggested that future research should examine F_{PP} and V_{PP} during different exercises to provide insight on the contributing factors of PP.

A potential limitation to this study may be the randomized order of the exercise sets. When using the JS in a practical setting, it is likely that athletes will warm-up using loads that progressively increase. However, the current study used a randomized design in order to eliminate a potentiation or fatigue effect and isolate the impact of the load on the variables of interest. Future research should consider performing a similar study with the JS while external loads are progressively increased to mimic a typical resistance training session. A second limitation of this study may be prescribing loads that are relative to each subject's 1RM-HC. Because it may be impractical to perform a 1RM-JS test, loads may be prescribed based on the body mass of each athlete as an initial starting point.

Conclusion

Statistical differences in PV, PP, F_{PP}, and V_{PP} existed in the current study while PF trended toward statistical significance. The F_{PP} and V_{PP} results at each load indicate that velocity contributes to PP more than force during the JS. Thus, practitioners should focus on improving the lift velocity of their athletes in order to improve their muscular power. The greatest PP occurred at 30% 1RM-HC, but was not statistically different from the PP at 45% 1RM-HC. It is recommended that practitioners should prescribe loads between 30% and 45% 1RM-HC for improvement in peak power. If the HC is not currently prescribed, practitioners should consider implementing loads relative to the body masses of their athletes. In this study, the loads of 30% and 45% 1RM-HC corresponded to approximately 39% and 58% of the body masses of the subjects, respectively. To provide information about PP production during the JS and other weightlifting variations, it is suggested that future research should examine F_{PP} and V_{PP}. Finally, based on the current training goal, practitioners should prescribe specific loading schemes that will provide optimal stimuli that will benefit the training and overall performance of their athletes.

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