Appendix

CEHD Grant Application Form

Submit this application form by one of the following due dates along with your proposal. Applications must be received, at tate-center@wmich.edu, by 5:00 p.m. on August 15, November 15, March 15, and June 15.

Application	
Applicant Name:	Sangwoo Lee, Ph.D.
Title:	Assistant Professor
Department:	HPHE
Title of Proposal:	Correlation profiles between lower extremity joint power and whole body power during the power clean.
Amount Requested:	$2,000
Dates of Project:	August /01/ 2016 – August /01/ 2017

Evaluation Guidelines

Strongly Agree 5	Agree 4	Undecided 3	Disagree 2	Strongly Disagree 1

Statement	5	4	3	2	1
The proposed research/creative activity is well conceived and organized.	☐	☐	☐	☐	☐
The proposed work will increase the likelihood that the applicant will secure external funding in the future.	☐	☐	☐	☐	☐
The methods and/or procedures are clearly stated and appropriate for the proposed activity.	☐	☐	☐	☐	☐
The plans for data analysis or evaluation critique are clearly stated and appropriate for the proposed activity.	☐	☐	☐	☐	☐
The costs for the proposed budget are clearly itemized and justified.	☐	☐	☐	☐	☐
This project has the potential to advance the scholarly/creative reputation of WMU.	☐	☐	☐	☐	☐

CORRELATION PROFILES BETWEEN LOWER EXTREMITY JOINT POWER AND WHOLE BODY POWER DURING THE POWER CLEAN

BACKGROUND

The power clean (PC) is one of the essential Olympic weightlifting techniques and technically subdivided into different phases based on the movement including first full, scoop, second full, and catch (2). The PC is also utilized in strength and conditioning training programs for athletes as an important part of power enhancement training. There have been studies conducted on power output during the PC (3,6,10). Most studies were primarily focused on determining an optimal load for maximizing power and identifying the timing of maximum power occurrence during the PC. For example, previous studies examined the effects of different loads on power output during the PC and it was shown that lifters generated the greatest amount of power when performing the PC with 60-80% of their maximum load and the maximum power output was observed in the second pull phase.

Power is the mechanical quantity defined as the rate of work and calculated as the product of force and velocity. In previous studies, power output during the PC has been analyzed using three different approaches: 1) barbell power calculated by the product of the barbell mass and velocity and 2) whole body (barbell + body) power calculated by the product of ground reaction force (force supplied by the ground, GRF) and whole body velocity, and 3) whole body power calculated by the product of GRF and barbell velocity (1,6,8,11). Hori et al. (2007) compared these different methods and stated that there were significant differences in peak power values between the method 1 and the method 2 and 3 due to differences in peak force. Also, there were significant differences in power output between the method 2 and 3 due to differences in peak velocity. It was concluded in the study that as a practical application, it is important to understand the characteristics of each power output calculation.

Lower extremity joints (the hip, knee and ankle joints) can play an important role in power generation during the PC because the PC performance begins with deadlift (10). Thus, it is highly likely that the main source of power output during the PC may be the joint power of lower extremity. There are two studies conducted on lower extremity biomechanics during the PC (7,9). Kipp et al. (2011) examined the effect of load on lower extremity biomechanics during the PC and the results of this study suggested that power and net torques (i.e. rotary force) of lower extremity joints vary across joint and load during the PC. Furthermore, Moolyk et al. (2013) investigated the percentage of each lower extremity joint work compared to total lower extremity work and net joint torques of lower extremity during the PC, and suggested that work performed at the knee was the greatest contributor to lower extremity work with the largest net joint torque generated. However, these studies focused only on lower extremity biomechanics and did not explain whether lower extremity joint power is related to power generation during the PC although understanding the role of lower extremity joints in whole body power output during the PC seems essential. Therefore, it is strongly believed that significant correlations between joint power of lower extremity and whole body power during the PC may exist.

In spite of the potential correlations between lower extremity joint power and whole body power during the PC, there has been no study investigating the correlations. It may be due to a methodological limitation in calculating whole body power and each joint power simultaneously. In previous studies measuring whole body power (3,4,6,8,10,11), for example, lifters performed the PC on a single force platform with both feet being on it to obtain overall GRF and whole body power was then calculated by the product of the overall GRF and either bar or whole body velocity. In order to calculate each lower extremity joint power, however, GRF needs to be independently collected from two force platforms with each foot being on each force platform. The limitation can be overcome by collecting overall GRF from both feet and independent GRF from each foot simultaneously.

PURPOSE

The purposes of this study are (1) to investigate correlation profiles between lower extremity joint power and whole body power during the PC and (2) to quantify how much each lower extremity joint contributes to whole body power.

HYPOTHESIS

1. Lower extremity joint power would significantly correlate with whole body power during the PC
2. The hip joint power would be the greatest contributor to whole body power during the PC, followed by the knee joint power, and the ankle power is the least contributor.

METHODOLOGY

Subjects

Ten subjects will be recruited for this study. Five males and females will be recruited to eliminate the influence of gender-induced homogeneity. The inclusion criteria will be 1) prior PC experience of at least 2 years, 2) no lower extremity joint or lower back injury history at least 12 months prior to this study, and 3) ability to perform the PC with appropriate PC posture. Prior to the initiation of the study, the subjects will be informed of the purposes of this study and asked to sign an informed consent form approved by Western Michigan University (WMU) Institutional Review Board.

Procedures

Each subject's 1 repetition maximum (RM) will be determined one week before the day of data collection using a 1RM testing protocol developed by the National Strength & Conditioning Association (2). The weight of the barbell will then be determined based on 1RM and 60% of 1RM will be used in this study (3). Prior to collecting actual PC trials, subject will perform warm-up with nine PC trials (three with a weighted bar only, three at 30%, and three at 60% of the subject's 1RM). A total of five PC trials will be collected in this study (at least 2-minute rest between trials to minimize fatigue).

Experimental Setup and Data Analysis

Forty-five markers (i.e. sphere-shaped plastic balls) will be placed on each subject's body. A real-time motion capture system in the biomechanics laboratory at WMU will be used to capture the three-dimensional (3D) coordinates of the markers during the PC. All the markers will be used to define joint centers and body segments. For example, the knee joint center is defined as the mid-point of the markers placed on lateral and medial femoral epicondyles and the thigh segment is defined from the hip joint center to the knee joint center. Two force platforms will also be used to measure GRF.

The whole body power output will be calculated by the product of combined vertical GRF and vertical velocity of the whole body (6,8). The combined VGRF will be obtained from two force platforms (Figure 1) and the vertical velocity will be calculated by integrating the combined vertical GRF with respect to time, and dividing by mass. Each lower extremity joint power will be calculated by the product of torque and angular velocity of each joint. The independent GRF collected from each foot will be used for the computation of joint power and the dominant side of the leg will be selected for data analysis (Figure 1).

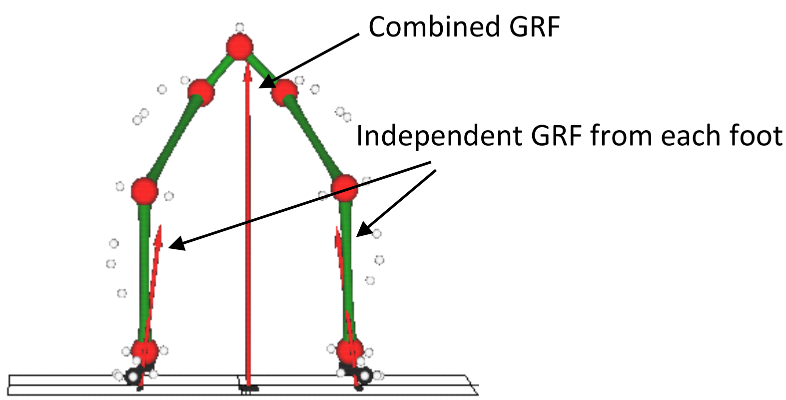

Figure 1. Lower extremity with combined vertical GRF and independent GRF.

Statistical Analysis

Pearson correlation coefficients will be obtained to observe the relationships between lower extremity joint power (hip, knee, and ankle) and whole body power. To determine the best combination of predictors of the whole body power, multiple-regression (stepwise) analysis will be conducted with the hip, knee, and ankle joint power being the independent variables. As the focus of the study is on the relationships among biomechanical parameters of the PC performance, five repeated trials will be treated independently. Statistical analyses will be conducted using IBM SPSS Statistics version 19 (IBM, New York) with the α level set at .05.

ANTICIPATED OUTCOMES

Correlation profiles between lower extremity joint power and whole body power and how much each lower extremity joint contributes to whole body power during the PC will be assessed in this study. Thus, a better insight into power generation during the PC will be provided to researchers as well as coaches, and current power enhancement training programs will be improved through this study by applying its results to the programs.

PLANS FOR CONTINUING RESEARCH

This research project will provide me with the basis for larger-scale future funding proposals directed toward Young Investigator Grant funded by National Strength and Conditioning Association Foundation (NSCAF). This grant program awards $15,000.

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BUDGET AND JUSTIFICATION

(omitted)