USING BARBELL KINEMATICS TO PROVIDE THE COACH WITH THE FEEDBACK FOR THE SNATCH

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The purpose of this study was to use three dimensional kinematics of the barbell to provide the coach with quick feedback for the snatch technique of an elite Taiwanese female weightlifter. Three high speed cameras were used to simultaneously record the barbell movements with film frequency of 200 Hz. The horizontal dispalcement-velocity relationship of the barbell seemed to have varied in a certain range while lifting a 95kg barbell. Based on these results, it was recommended the lifter attempt 95kg for her first attempt in the competition. In conclusion, the barbell kinematics is a quick and easy approach to provide the coach with feedback for the snatch. The information of trajectory and movement characteristics of the barbell could provide the coach and the lifter to assist in improving the lifter's snatch technique.

KEY WORDS: olympic weightlifting, phase diagram, three dimensional kinematics.

INTRODUCTION: The barbell kinematics of the snatch lift that included the barbell trajectory, velocity and acceleration has been analyzed in the past studies. The barbell trajectory could be divided into three types. Most of the elite weightlifters seemed to perform the type II of barbell trjectory that the barbell always moves behind the vertical reference line through the barbell ready position during the snatch (Chiu et al., 2010; Musser, 2010; Schilling et al., 2002). The displacement-velocity relationship of the barbell, or phase diagram, has been used to present the movement characteristics of barbell in the horizontal and vertical direction (Chiu et al., 2010). The study of Chiu et al. showed that the best lifters performed less variation in horizontal displacement and velocity of barbell.
A coaching feedback for an individual to improve snatch technique was carried out in a recent study (Ho et al., 2011). However, the subject was a novice weightlifter and the methods used in the study were complex and perhaps adequate to operate in the laboratory. The purpose of this study was to use three dimensional kinematics of the barbell to provide the coach with quick feedback for the snatch lift technique of an elite Taiwanese female weightlifter. It was anticipated that this study would provide the sport scientist with an easy and quick approach to evaluate the snatch technique of the elite weightlifter.

METHODS: An elite felmale weightlifter (age: 22yrs, height: 159cm, body weight: 55kg) was included in this study. Three high speed cameras were used to simultaneously record the barbell movements with film frequency of 200 Hz. The kinematics data were smoothed and analyzed by KWON 3D software (Visol, Korea). Six events defined in this study included (Figure 1): lifting the barbell off the floor (LO), clearing the barbell past the knee of the lifter (CK), extension of the lifter's hip joints to push the bar away from her body (PB), the barbell reaching its maximum forward position (MF), the barbell reaching its maximum vertical height (MH), and the lifter catching the bar overhead (CB).

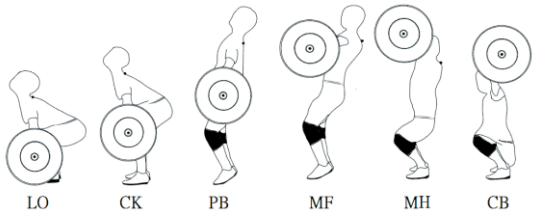

Figure 1: The six events defined in this study.

RESULTS: Feedback of the barbell kinematics including trajectories (Figure 2) and relationships between the displacement and velocity of the barbell in horizontal and vertical direction (Figure 3) were offered to the coach (Figure 4). From the barbell trajectories of the four successful lifts, the female lifter performed the type II of trajectory that the barbell always moves behind the vertical reference line. The maximum height of the barbell movement was about 96~98cm.

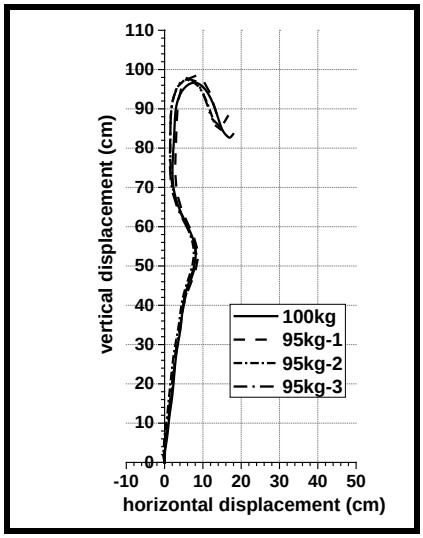

Figure 2: Barbell trajectories of the four successful lifts for the female weightlifter.

In the horizontal, the maximum barbell forward velocity of about 0.8~0.9m/s occurred between the PB and MF events. After the MF event, the barbell moved at the maximum backward velocity of 0.4~0.5m/s near the MH event. As shown in the feedback for the 100 kg of snatch (Figure 4), the barbell achieved its maximum horizontal and vertical velocity after the PB event, and the peak forward velocity (0.84m/s) of the barbell occurred prior to its peak upward velocity (1.87m/s). It is worth noting that the horizontal displacement-velocity relationship of the barbell varied in a certain range for the three lifts of 95kg. In the successful lift of 100 kg, the relationship curve seemed to move exactly in the range. However, another two failed lifts of 100kg that were not shown in this study demonstrated a relationship curve out of the range.

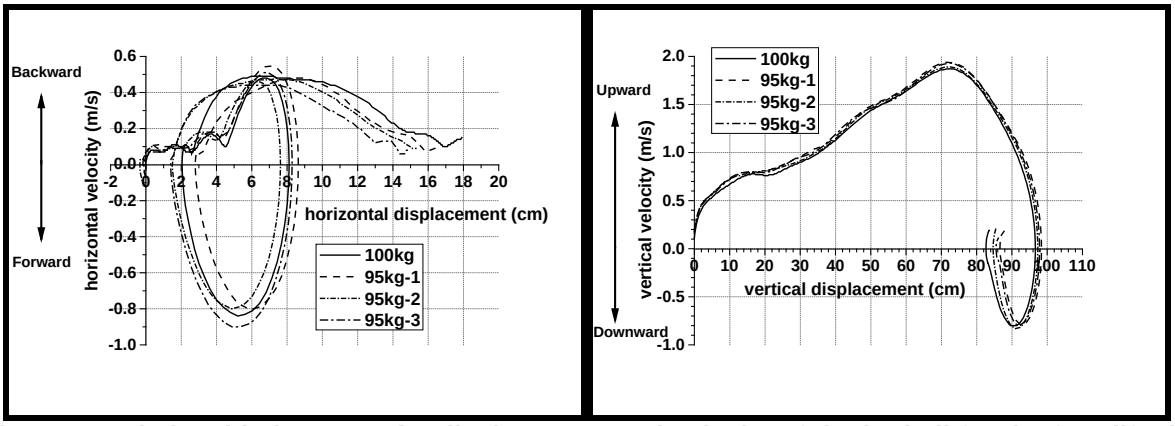

Figure 3: Relationship between the displacement and velocity of the barbell for the four lifts in horizontal and vertical direction.

DISCUSSION: The characteristics of the displacement-velocity relationship of the barbell for the female lifter were similar to those of the elite Taiwanese male weightlifters both in

horizontal and vertical direction (Chiu et al., 2010). In the vertical, the lifter performed an "effective" snatch lift in which the vertical barbell velocity increased continuously from the LO event, until achieving the maximum velocity (Gourgoulis et al, 2002). In the horizontal, the maximum barbell's backward velocity near the MH event showed that lifter jumped backward to catch the bar and started to apply the force on the bar as the bar moving near its maximum vertical height.
Less variation in the horizontal movement of barbell has been shown more often for the best lifters than for the less skilled lifters (Chiu et al, 2010). In this study, the horizontal dispalcement-velocity relationship seemed to have varied in a certain range while lifting a 95kg barbell. Based on thses results, it was recommended the lifter attempt 95kg for her first attempt in the competition.
The elite female weightlifter in this study won the gold medal in the 2014 Asian Games and her total weight for both snatch (101kg) and clean and jerk (132kg) lifts created a new world record for the women's 53kg class. The barbell kinematic model of this lifter's snatch lift could be a good reference to evaluate the snatch technique for the female weightlifter.

CONCLUSION: The barbell kinematics is a quick and easy approach to provide the coach with feedback for the snatch lift. From the barbell kinematics as shown in this study, the information of trajectory and movement characteristics of the barbell could be offered to the coach and the lifter in a short time, for example in one week, to assist in improving the lifter's snatch technique.

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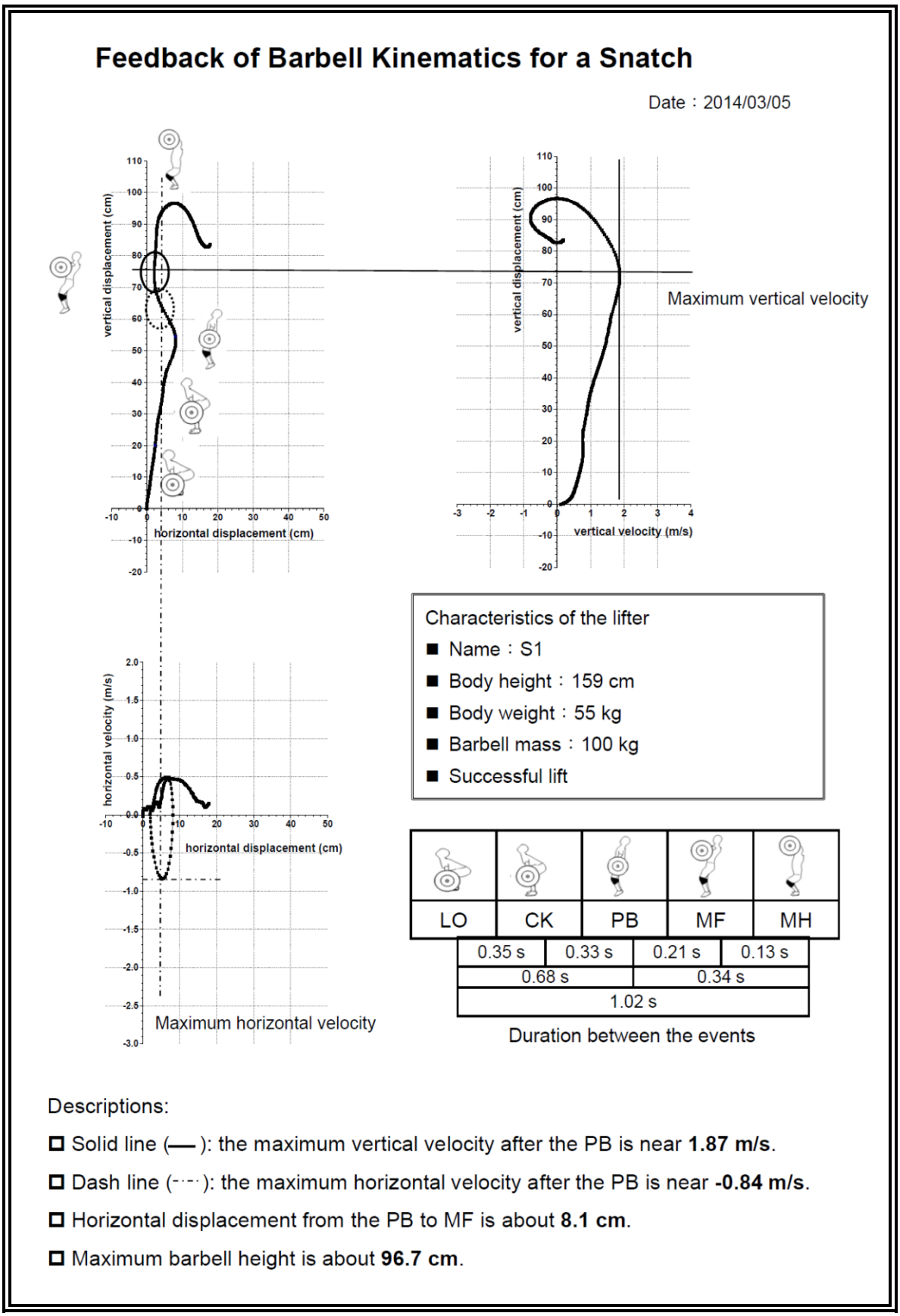

Figure4: The feeback of the barbell kinematics for the coach.