BCH ANGLES OF YOUNG FEMALE WEIGHTLIFTERS DURING SNATCH MOVEMENT

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This study is aimed at using the BCH angle which represents the relative movement of lifter's body and barbell to compare the snatch movement of two young female weightlifters. The snatch movements of these two female weightlifters were filmed by a high speed camera (120Hz) and analyzed by Kwon 3D motion analysis software. The BCH angle, defined as the angle between the projection vector of the 7th cervical spinous process to the barbell and the projection vector of the 7th cervical spinous process to the hip joint in the sagittal plane, was calculated. The differences of BCH angles during the whole snatch movement have been found between successful and unsuccessful lifts for S1, and even between successful lifts of S1 and S2. In conclusion, the BCH angle seems to be a simple and good variable to evaluate the snatch techniques of the weightlifters.

KEYWORDS: barbell, successful lifts, film analysis

INTRODUCTION: The general kinematical characteristics of the barbell during the snatch for elite weightlifters have been determined in previous studies (Garhammer, 1985; Isaka et al.,1996; Baumann et al., 1998; Gourgoulis et al.,2000). Most studies acquired the kinematics of the barbell or the weightlifter's lower extremity joints under a single competitive or laboratory condition and eventually concluded that there was no parameter that was significantly different between successful and unsuccessful lifts (Stone et al., 1998). Furthermore, elite weightlifters seemed to have no one standard method to snatch the bar successfully (Chiu et al., 2007). The results of previous studies have shown that correcting some important bar path parameters by using visual and verbal feedback will not only improve the technique of the power clean or snatch for the lifters, but will also translate to increase power and force production in the athletes performing the lifts (Winchester et al., 2005; Winchester et al., 2009). In these studies, the verbal feedback was provided as to how to adjust body movement to obtain an optimal bar path as outlined by Stone et al. (1998). From the above studies, investigating the relative movement between the bar and the body of the lifter seemed to be more adequate to evaluate the technique of the snatch than alone analyzing the bar path or the kinematics of the body movement.

The BCH angle, a new single parameter which represents the relative movement of the lifter's body and the barbell, has been validated to characterize the snatch movements of an elite young female lifter (Chiu, et al., 2009). This study involved filming the snatch movement of two young female weightlifters and attempted to use the BCH angle to compare their snatch techniques.

METHODS: The snatch movements of two young female weightlifters were filmed on two different days. The physical characteristics and the lifted barbell mass of the two subjects are showed in Table1. Nine lifts of S1 (6 successful and 3 unsuccessful lifts) and eleven lifts of S2 (6 successful and 5 unsuccessful lifts) were analyzed and compared. This investigation was approved by the Human Experiment and Ethics Committee of the National Cheng Kung University Hospital. The subjects were informed of the experimental risks and signed an informed consent before participation.

A high-speed camera (Mega Speed MS1000, sampling rate: 120 Hz) was set on the left side of the lifters to film the snatch movement in the sagittal plane. A calibration rectangular plane (100cm long, and 140cm high) with 30 control points was used in this study. The two dimensional spatial coordinates of the selected points were calculated using a direct linear transformation procedure by Kwon 3D motion analysis software. The reconstruction errors were 0.21 and 0.25cm for the film analysis in the two days. The raw data was smoothed using

a 4th-order butterworth low-pass filter at a cut frequency of 6Hz. The barbell mass lifted was determined by the coach's instruction and the order was similar to that adopted in competitions.

Table 1. Physical Characteristics and the Lifted Barbell Mass of the Two Subjects.

Subject	Age (yrs)	Weight (kg)	Height (cm)	The barbell mass for the two different days (kg)
S1	19	54	157	1st: 80*, 80*, 83, 83*, 85, 85 2nd: 83*, 85*, 87*
S2	18	59	153	1st: 60*, 62*, 64*, 65, 65, 65 2nd: 62*, 63*, 64, 64, 64*

* Successful lifts

The six events defined in this study included: 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 his 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). The BCH angle defined as the angle between the projection vector of the 7th cervical spinous process to the barbell and the projection vector of the 7th cervical spinous process to the hip joint in the sagittal plane was calculated. To take into account the fewer lifting numbers, independent t-test with SPSS statistical package was used, but only to compare the BCH angles of the two lifter's successful six lifts at the six events ($\alpha = 0.05$).

RESULTS: Table 2 shows the BCH angles of S1 and S2 in successful and unsuccessful lifts at the six events. The BCH angle of S2 was significantly greater than that of S1 only at the MF event. Although there is no statistical analysis, the mean BCH angles of S1 were smaller in unsuccessful lifts than those in successful lifts at the PB, MF and MH events.

Table 2. The BCH Angles (degree) of S1 and S2 in Successful and Unsuccessful Lifts at the Six Events.

Events	Successful lifts of S1（n=6）	Unsuccessful lifts of S1 (n=3)	Successful lifts of S2 (n=6)	Unsuccessful lifts of S2 (n=5)
LO	42.0 (4.5)	43.7 (2.0)	44.2 (3.1)	44.0 (2.5)
CK	34.7 (2.3)	35.5 (2.5)	36.0 (2.2)	37.3 (2.8)
PB	7.8 (5.0)	1.5 (1.5)	9.0 (6.14)	7.8 (5.8)
MF	27.1* (1.0)	23.8 (1.1)	59.0* (5.8)	60.6 (4.6)
MH	116.6 (4.5)	109.5 (3.7)	122.9 (6.7)	122.1 (8.3)
CB	198.5 (8.8)	208.6 (23.4)	194.9 (7.1)	192.9 (22.8)

* Significant difference between the successful lifts of S1 and S2 ($p < 0.05$).

After the CK event, the BCH angle decreased more slowly and the angular velocity rapidly decreased prior to the PB event in unsuccessful lifts for S1 (Figure1). However, the BCH angle of S2 decreased more rapidly after the CK event than S1 and there is also a marked decrease of angular velocity between the CK and the PB event (Figure 2). Approaching the

MH event, there is a maximum BCH angular velocity. It is obvious that the peak BCH angular velocity was greater in unsuccessful lifts for S1 (Figure1).
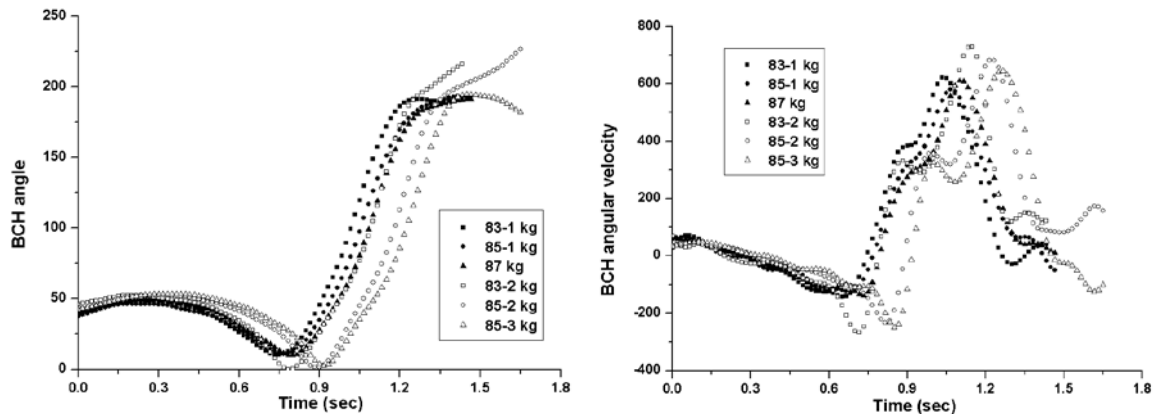

Figure 1. The BCH angle (degree) and angular velocity (deg/s) during successful lifts (■,●,▲) and unsuccessful lifts (□,○,△) for S1.
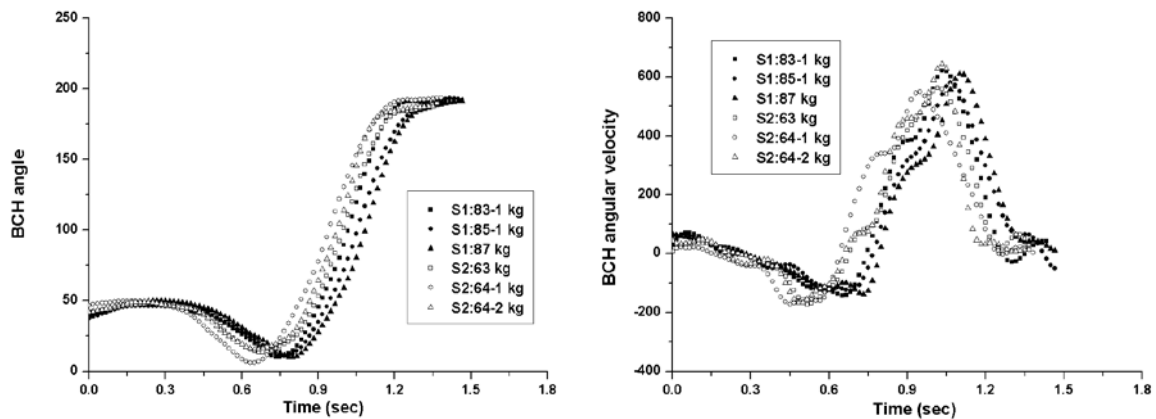

Figure 2. The BCH angle (degree) and angular velocity (deg/s) during successful lifts for S1 and S2.

DISCUSSION: This present study attempted to use the BCH angle to evaluate the snatch technique. In previous studies (Stone et al., 1998), there were no parameters significantly different between the successful and unsuccessful lifts. However, differences between the BCH angles of S1 during the whole snatch movement have been found between successful and unsuccessful lifts in this study (Figure 1). The previous study showed that the female lifter performed with the same BCH angles from the LO to the CK event as lifting a barbell of 80～ 82 kg (Chiu and Liang, 2009). In this present study, this female lifter also had a stable performance from the LO to the CK event. However, after the CK event, her BCH angles decreased slowly in unsuccessful lifts. Even though the rapidly following reduced BCH angles were performed to compensate for the prior slower movement, the greater BCH angular velocity at the MH event caused the bar to drop backward.

In this study, the two female subjects had different snatch techniques. Subject 1 pulled the bar with a jump backwards resulting in a catch position farther behind the initial position of the barbell than subject 2 who caught the bar in the initial position or slightly forward. However, the pattern of the BCH angle and the angular velocity curves during the whole snatch movement for S2 were similar to S1. The difference between the snatch techniques of the two lifters perhaps is that subject 2 had rapid decreased BCH angles after the CK event. Eventually, she pushed the bar earlier or perhaps at a lower position to her thighs and that caused a greater BCH angle at the MF event (Table2). The mean greater BCH angle (59.0±5.8 degree) at the instant the barbell reached maximum forward position means that

the lifter's upper body is farther away from the barbell. This will increase the difficulty in catching the bar in time as the bar drops down.

CONCLUSION: In this study, the differences of BCH angles during the whole snatch movement have been found between successful and unsuccessful lifts for S1, and even between the successful lifts of S1 and S2. The BCH angle seems to be a simple and good variable to evaluate the snatch techniques of the weightlifters. Based on the results, subject 1 should avoid the slowing of the decreased BCH angle as she is pulling a heavier barbell, especially from the CK to the PB event. Conversely, subject 2 should slow her pulling bar movement and push the bar from the upper position of her thighs.

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