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THE RELATIONSHIP BETWEEN THE BARBELL TRAJECTORIES OF SNATCH AND BCH ANGLES

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The purpose of this study is to investigate the relationship between the barbell trajectories of snatch and the angle between the projection vector of 7th cervical spinous process (C7) to barbell and the projection vector of C7 to hip joint in the sagittal plane (BCH angles) in different events. The ten weightlifters were divided into two groups according to their barbell trajectories (BT was categorized into the backward barbell trajectories, and the FT was forward). The results show that the BCH angles at PB and MF in BT are smaller than FT. The weightlifers with the backward trajectories usually make better performances. After analysis, we find out that the backward trajectories would reduce the BCH angles. The present study suggests that catching the bar with backward trajectories and smaller BCH angles at PB and MF are perhaps a better technique for snatch.

KEY WORDS: Weightlifting.

INTRODUCTION: Weightlifting requires high skill and stability. In the snatch, the lifter pulls the barbell from the plat-form and catches it overhead in a continuous motion with arms fully extended, and then stands with the barbell in control. The lifter lifts the barbell off the floor, pushes it away from himself and catches it overhead during snatch.
The barbell kinematics during the snatch for elite weightlifters have been investigated in previous studies. Several studies have described the relationship between barbell trajectories and the performance during snatch. An elite weightlifter performed with a great stability of barbell and limbs (Gourgoulis, Aggeloussis, Garas, & Mavromatis, 2009). A successful lift trajectory is crucial. Most of the elite weightlifters in Taiwan and Greek have a backward trajectories (Gourgoulis, Aggeloussis, Garas, & Mavromatis, 2009; Chiu, Wang, & Cheng, 2010). Chiu, Wang, & Cheng (2010) discovered that male weightlifters who has a better skill performed with a higher barbell travel range in vertical direction. Schilling, et al. (2002) indicate that foot displacement did not significantly affect snatch success or lifting ability in collegiate national level lifters.This study aimed to investigate the relationship between barbell trajectory and the BCH angles. It was hypothesized that the BCH angles in the group with backward trajectories would be smaller than the group with forward trajectories.

METHODS: Ten weightlifters (5 males and 5 females) were recruited in this study. They were devided into two groups according to their barbell trajectories. There are five people in Group A: S1 and S6 in lightweight, S4 in superheavy weight, S9 in heavy weight and S10 in middle weight. They are all with BT. There are also five people in Group B: S5, S7 and S8 in middle weight, S11 in superheavy weight and S12 in lightweight. They are all with FT. BT was categorized into the backward barbell trajectories, and the FT was forward (Figure 1: BT: n=5; age=18±0.71years; body mass=72.8±11.97 kg; height=160.8± 7.85cm; FT: n=5; age=17±1.58years; body mass=70.4±13.83 kg; height=162.2± 8.58cm). The 46 and 38 successful lifts respectively for BT and FT were analyzed. Every lifting weight exceeds 85% of subjects‘ personal 1RM.
A high speed camera (Mega speed MS1000, sampling rate=120 Hz) was used to collect the snatch movement in the sagittal plane, and put on the left side of the lifters. 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 less than 0.25cm for the film analysis on the different days. The raw data were 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.

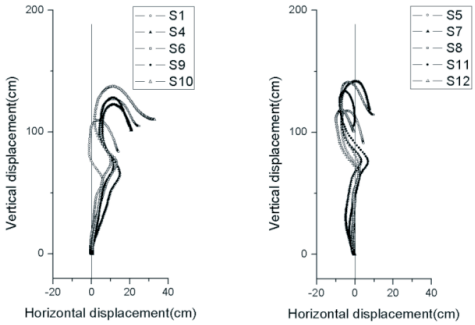

Figure 1: The barbell trajectories of snatch groups (BT is the left one of the figure and FT is the right one).

The 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 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 definition of BCH angle was 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 (Figure 2).

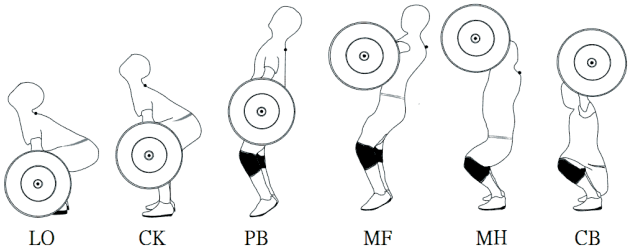

Figure 2: The six events included: LO, CK, PB, MF, MH and CB (from left to right in order).

Figure 3: The BCH angle.

RESULTS: The BCH angles of BT and FT at different events are shown in table 1. Llifter bent upper body, knee and hip to lift the bar from floor at LO, extent trunk at CK, and then pulled the barbell as close to their body as possible at PB. During this period, the BCH angles of weightlifters would decrease continuously. At the event of MF, weightlifters started to push the barbell away from themselves. And the barbell would over the head and approach the maximun height at MH. The last event of snatch was CB. It is when the lifter

would squat and lower his body rapidly and get ready to catch the barbell behind his head. During the last three events, the BCH angles kept increasing. The BCH angles at the LO and CK of BT are similar to FT. But there are significant diferences were found at the PB and MF between two groups,the BCH angles at PB and MF are smaller in BT.

Table 1
BCH angles of snatch events

BCH angle	BT	FT
LO	40.17±3.65	40.04±4.08
CK	34.48±3.12	34.68±3.42
PB*	7.49±3.64	10.55±5.99
MF*	32.51±6.29	61.85±13.31
MH	145.31±21.92	140.53±13.16
CB	208.79±10.04	195.01±8.23

* $p < 0.01$

DISCUSSION: The trajectories of S7and S8 are obviously higher than the others at MH. This is commonly due to the unstable lifting of the barbell. Unstable lifting would cause the bar to tilt to one side and therefore, if we use the 2D analysis, we can only snap-shot the lifters from one plane. The barbell trajectories would be captured with some inaccuracies. In this way, the 2D analysis is not the best way for weightlifting.

While lifting, the lifters of BT have a smaller BCH angle at the events of PB and MF. The smaller BCH angles indicate that the barbell is closer to the lifters. It would be easier for lifters to catch the bar if they are positioned closer to the barbell. Comparing the RBM (the ratio of the barbell mass to the lifter's body weight) from the two groups, most of the better lifters who have greater RBM are belonged to the group of BT.

In present study, there is a significant difference at PB between the two groups that was similar to Gourgoulis, Aggeloussis, Garas, & Mavromatis' (2009) study. Chiu, Wang, & Cheng (2010) found that , the lifters with backward trajectories contribute to a better performance in Taiwanese weightlifters, and a lighter lifter could lift a relatively heavier barbell with backward trajectories (Schilling, et al., 2002), above result and present study were alike. And there was a same finding in Greek weightlifters (Gourgoulis, Aggelousis, Mavromatis, & Garas, 2000).

CONCLUSION: Based on the results, the BCH angles at PB and MF are smaller in BT. Small BCH angles indicate that the barbell is closer to the lifters and this would be easier for lifters to catch the bar if they are positioned closer to the barbell. Most of the better lifters are belonged to the group of BT. According to the above, the present study suggests that catching the bar with backward trajectories and smaller BCH angles at PB and MF are perhaps a better technique for successful snatch.

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