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CORRELATION IN THE BARBELL AND LOWER LIMB KINEMATICS PERFORMANCE PARAMETERS IN THE SNATCH LIFTS: A PILOT STUDY

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In our knowledge, there was not a lot of research to understand the relationship of snatch lifting. Therefore, the purpose of this study was to investigate the relationship between the barbell and lower limb kinematics parameters during the second pull of the snatch lifts. There were two digital cameras to record the snatch lifts. The study used the Kwon 3D motion analysis system to obtain the barbell and lower limb kinematics parameters. They study used the Pearson's product moment correlations to investigate the relationship between the barbell and lower limb kinematics parameters. The results showed the significant relationship between the maximum vertical height of the barbell and the maximum extension angle of the hip joint. It also showed the significant relationship between the maximum extension angle velocity of the knee joint and maximum extension angle of the knee joint. The present study suggests that increasing the muscle quality and power of the lower limbs will increase the maximum vertical velocity of the barbell.

KEY WORDS: snatch, barbell, efficiency technique.

INTRODUCTION: The snatch technique was combined with the continuous and fast motion in the limbs to produce the barbell movement. During the second pull, the lifter must be explosive and fast to extend the lower limb to produce the maximum vertical velocity of the barbell, and to reach the maximum vertical height of the barbell. The technique in this phase is considered to be most important because the lifter stored elastic energy. The lifter used the stretch reflex of the knee extensors during the transition phase, then followed with the release of elastic energy on the barbell during the second pull (Garhammer, 1989; Isaka Okada, & Funato, 1996).

Isaka et al. (1996) analyzed the relationship between the maximum vertical velocity of the barbell and horizontal travel range (HTR). The results in this study were obtained with the significant positive correlation in elite Asian weightlifters. This is represents that the lifters need to use the wide range of the HTR to produce the fast velocity of the barbell. This lift requires immense amounts of energy.

However, in our knowledge, there was not a lot of research concerning the correlation between the barbell and lower limb kinematics performance in the snatch. There is only one study using the correlation to understand it (Isaka et al., 1996). Based on this previous knowledge, the purpose of this study was to understand the relationship between the barbell kinematics and lower limb kinematics parameters during the second pull of the snatch.

METHODS: The subjects included 8 male Taiwanese weightlifters (age: 21.4±1.6 yrs, height: 174.5±4.0 cm, weight: 82.1±10.0 kg, and an experience in training of 7.4±1.8 years). Each lifter performed their best efforts in 90 % of their one repetition maximum (1RM) (106.9±7.5 kg) for analysis. Two digital cameras (Sony DCR-TRV 15, sampling rate: 60Hz) were positioned in a horizontal plane with a distance of 12 meters away from the platform to record the snatch lifts. The optical axis of the 2 cameras were approximatly a 90° angle with the frontal plane for the lifter. The cameras were synchronized using the lift-off of the barbell from the platform. To determine the 3-dimensions of the barbell and angular kinematics of the hip joint, knee joint, and ankle joint were selected. A point end of the barbell and the lower limb points were seclected: the iliac spine, top of tibia, medial malleouls, and top toe of the right side to digitize it. All the 3-D coordinates of the markers were calculated using the DLT (direct linear transformation) procedured by the Kwon 3D motion anlysis system. A Butterwoth loss pass fourth order filter was used with a cut-off frequency of 6Hz that smoothed the raw data. The mean reconstruction error values were between 0.33~0.37 cm. The five phases of the snatch lifts were according to the Gourgoulis et al. (2000) methods to divide it, Figure 1. The phase included: First pull (Fig 1. a-b), Transition phase (Fig 1. b-c), Second pull (Fig 1. c-d), Turnover phase (Fig 1. d-e), Catch phase (Fig 1. e-f). In the present study the focus was on the second pull of the snatch. The Pearson's product moment correlations to investigate the significant difference of the barbell kinematics and lower limb kinematics parameters in both lifts. The level of significance was set at α= .05.

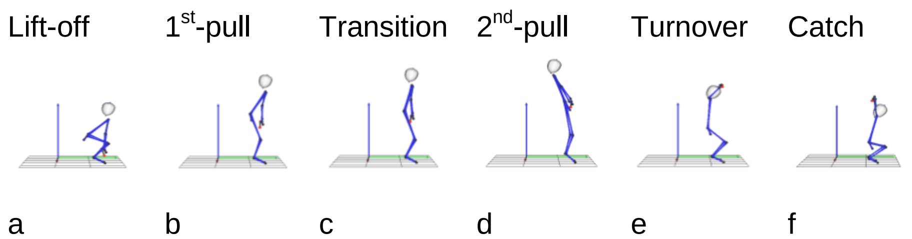

Figure 1: The five phases of the snatch lifting.

RESULTS: The results of the barbell kinematics and lower limb kinematics parameters are listed in Table 1. The HTR was greater than the previous studies (Gourgoulis et al., 2000; Harbili, 2012), but smaller than Olympic gold medal winners lifters and elite Asian lifters (Garhammer, 1985; Isaka et al., 1996). The maximum vertical height of the barbell and maximum vertical velocity of the barbell was similar with the previous studies (Garhammer, 1985; Gourgoulis et al, 2000; Isaka et al., 1996). In the angular kinematics, the maximum extension angle of the knee and ankle joints were similar with elite Greek lifters (Gourgoulis et al., 2000), but the maximum extension angle of the hip joints were greater than elite Greek lifters (Gourgoulis et al., 2000) and smaller than the 2010 World championships lifters (Harbili, 2012). In addition, the maximum extension angular velocities of the hip and knee joints of the elite Greek lifters were greater than current study results.

Table 1

Barbell and Lower Limb Kinematics Parameters During The Second Pull In Snatch Lifts.

Parameters	Successful (n=8)
Barbell kinematics	
HTR (cm)	6.2 ± 4.0
MH (cm)	106.4 ± 6.0
Max Vv (cm/s)	188.0 ± 9.9
Lower limb kinematics	
Max Hip Ext. Ang. (deg)	200.8 ± 6.1
Max Knee Ext. Ang. (deg)	158.9 ± 6.9
Max Ankle Ext. Ang. (deg)	118.3 ± 4.9
Max Hip Ext. V. Ang. (deg/s)	384.4 ± 29.5
Max Knee Ext. V. Ang. (deg/s)	325.3 ± 71.6
Max Ankle Ext. V. Ang. (deg/s)	303.5 ± 37.2

HTR: Horizontal travel range; MH: Maximum vertical height of the barbell; Max Vv: Maximum vertical velocity of the barbell; Max Hip Ext. Ang. : Maximum extension angle of the hip joint; Max Knee Ext. Ang. : Maximum extension angle of the knee joint ; Max Hip Ext. V. Ang. : Maximum extension angle velocity of the hip joint; Max Knee Ext. V. Ang. : Maximum extension angle velocity of the knee angle; Max Ankle Ext. V. Ang. : Maximum extension angle velocity of the ankle joint

The Pearson's correlation coefficients are shown in Table 2. The results show the significant relationship between the maximum vertical height of the barbell, the maximum extension angle of the hip joint (r = 0.75, *p* = .033), the significant high relationship between the maximum extension angle velocity of the knee joint and maximum extension angle of the knee joint (r = 0.88, *p* = .004). This means that the lifters performed the faster extension of the hip joint to produce the maximum vertical height of the barbell.

Table 2

Pearson Correlations Coefficients Between The Barbell And Lower Limb Kinematics Parametes In Snatch Lifts.

Kinematic Parametes	1	2	3	4	5	6.	7
1 HTR	—						
2 MH	0.23	—					
3 Max Vv	0.16	-0.21	—				
4 Max Hip Ext. Ang.	0.30	0.75*	0.20	—			
5 Max Knee Ext. Ang.	-0.31	0.60	0.23	0.64	—		
6 Max Knee Ext. V. Ang.	0.18	0.33	0.58	0.58	0.88**	—	
7 Max Ankle Ext. V. Ang.	-0.14	0.14	0.21	-0.15	0.44	0.33	—

*$p < .05$; **$p < .01$

HTR: Horizontal travel range; MH: Maximum vertical height of the barbell; Max Vv: Maximum vertical velocity of the barbell; Max Hip Ext. Ang. : Maximum extension angle of the hip joint; Max Knee Ext. Ang. : Maximum extension angle of the knee joint ; Max Hip Ext. V. Ang. : Maximum extension angle velocity of the hip joint; Max Knee Ext. V. Ang. : Maximum extension angle velocity of the knee angle; Max Ankle Ext. V. Ang. : Maximum extension angle velocity of the ankle joint

DISCUSSION: The present study was the pilot study to understand the relationship between the barbell and lower limb kinematics parameters, because the previous studies were only to analyze the relationship between the maximum vertical velocity of the barbell and HTR (Isaka et al., 1996). The present study results differed with the previous study (Isaka et al., 1996). The results in this study were obtained by the significant relationship between the HTR with the Max Vv (r = 0.916, $p < .05$), but in our results there was no significant relationship (r = 0.16, *p* = .702). The elite Asian lifters performed the wide range of the HTR so the results were 8.4 cm (Isaka et al., 1996), it was greater than our study and elite Greek lifters and the 2010 World championships lifters who participated (Gourgoulis et al., 2000; Harbili, 2012). Baumann, Gross, Quade, Galbierz, & Schwirtz (1988) indicated a new pulling technique where the lifters pull the barbell close to the body, and during the turnover under the barbell, jump backwards to catch the barbell overhead with arms fully extended. Perhaps this means that the pulling technique was not similar with past lifters, like the elite Asian lifters. This means the current lifters pulled the barbell closer to the body direction than the elite Asian lifters.

In addition, the research of snatch indicated the second pull was very important to the lifters (Baumann et al., 1988; Gourgoulis et al., 2000). This is because the release of elastic energy must be used to achieve explosive and fast speed to transform the energy onto the barbell to produce and to obtain the required velocity and the maximum vertical height (Garhammer, 1985; Gourgoulis et al., 2000; Isaka et al., 1996). The results in Table 2 showed that the lifters must have a fast extension of the knee joint to produce the maximum extension angle of the knee joint. Meanwhile, the wide range of the extension of the hip joint transforms the energy on the barbell to produce the maximum vertical velocity.

According to the view of the training points, in the present study our results suggested if the coaches want to correct the snatch technique during the training classes, they must increase the lower limb muscle strength and power ability. This will improve the lifters ability to flex and extend the muscle extensors of the knee and hip joints. Therefore, these results are important for the coaches to know in the training process. The coaches must pay attention to the change of the knee joints during the transition phase and second pull in the snatch lifts when the barbell movement passes the knee joint. Also, they must pay attention to the extension velocity of the knee joints and extension range of the hip joints during the second pull in the snatch lifts. This is because the lifters can use this information to produce a stronger explosion of the muscle extensor in the lower limb during the second pull.

CONCLUSION: The efficiency technique of the snatch performance provides the ability to perform a wide range of the extension of the hip joint to increase the maximum vertical height of the barbell. Therefore, the present study suggests that increasing the muscle quality and power of the lower limbs would increase the maximum vertical velocity and height of the barbell during the snatch. Also, there should be a focus on the extension range of the knee joint during the second pull in the snatch technique.

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