ANALYSIS OF JUMP BACK KICK MOVEMENT IN TAEKWONDO

Chen-Lin Lee

Xin Sheng Taekwondo Training Center, Taipei, Taiwan

The purposes of this study were to observe the kinetic chain in attack leg and the ground reaction force (GRF) of support leg in jump back kick. Seven male Taewondo athletes (age: 21.0 ± 2.2 year old; height: 180.4 ± 4.4 cm; weight: 77.7 ± 13.2 kg) were subjects. Two Redlake cameras synchronized with a Kistler force platform were collected the GRF data. Kwon 3D analyzed the kinematic data and KwonGRF analyzed the kinetic data. The results indicated the attack leg was not following kinetic chain during kicking phase whereas the knee and ankle angle support leg were from extension to flexion. The GRF of support leg was the peak vertical force appearing before the peak horizontal force during rotation phase. When subjects kicked the bag, it reached to apex of center. When support leg utilized toe rotation, the center of pressure (COP) of medial-lateral had more displacement. However, the COP of anterior-posterior shifted forward and increased the displacement.

KEY WORDS: Kinetic chain, Ground reaction force, Center of pressure

INTRODUCTION:

With regard to Taekwondo rule change in 2000, round house kicks is a mainstream movement and coaches developed more offensives for Taekwondo athletes. Lee and Huang (2006) comparing basis back kick, jump back kick and 360°jump back kick movement indicated jump back kick is useful counterattack movement in Taekwondo match. However, it is fewer studies about jump back kick. How about the pattern of attack leg and support leg during kicking phase? How much force applies to the ground during rotation phase? Therefore, the purposes of this study were to observe the kinetic chain of attack leg and the ground reaction force (GRF) of support leg in jump back kick.

METHODS:

Seven male Taekowndo athletes (age: 21.0 ± 2.0 year old, height: 180.4 ± 4.4 cm, weight: 69.1 ± 26.1 kg） who have experience of national competition participated in this study. The main equipment included two Redleke cameras, Kister force platform and Biovsion system. Two Redlake cameras (60 Hz) synchronized with a Kistler force platform (1200 Hz) were used to collect the data of the Jump back kick movement. Kwon 3D analyzed the kinematic data and KwonGRF analyzed the kinetic data. The accelerometer was fixed on kicking bag (20kg), and Biovsion system was used to recode acceleration and calculate the gravity value.

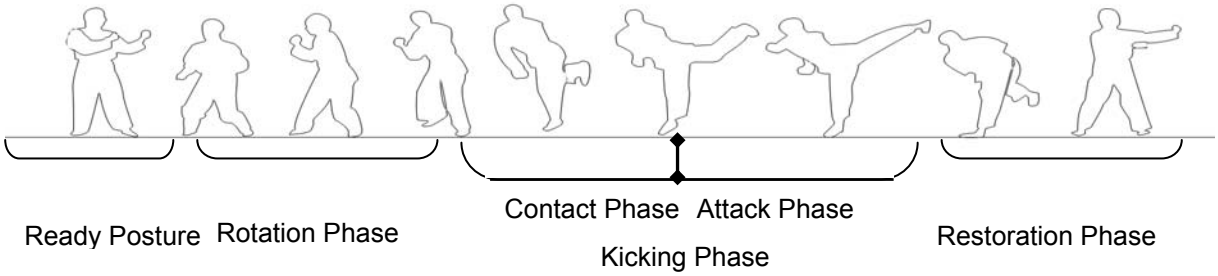

Figure 1: Illustration of Jump Back Kick

Jump back kick (JBK) was divided into the rotation, kicking and restoration phases. Rotation phase was defined as the minimum support leg knee angle and whole body starting turn back to leave ground. Kick phase was defined as a support leg jumping leave the ground to straight leg. Kicking phase included attack and contact phase. Contact phase was defined as the minimum attack leg knee angle to straight leg. Attack phase was defined as the attack leg hit the bag to straight leg (Figure 1).

The variables for this study are: hip knee and ankle angular velocity of attack leg; hip, knee and ankle linear velocity of attack leg; hip knee and ankle angle of support leg; jumping height defined as a vertical displacement of center of mass; GRF of support leg was normalized to body weight（BW）and center of pressure (COP) of support leg. Each subject performed the JBK three times. The data of the maximum gravity of bag from three trials was analyzed.

RESULTS:

The results indicated the attack leg was not following kinetic chain, not only angular (Figure 2) but also linear (Figure 3), during kicking phase. The sequence of angular velocity was ankle, knee to hip. The sequence of linear velocity was hip, ankle to knee. Because seven subjects have the same trend, so the figure presented one of subject

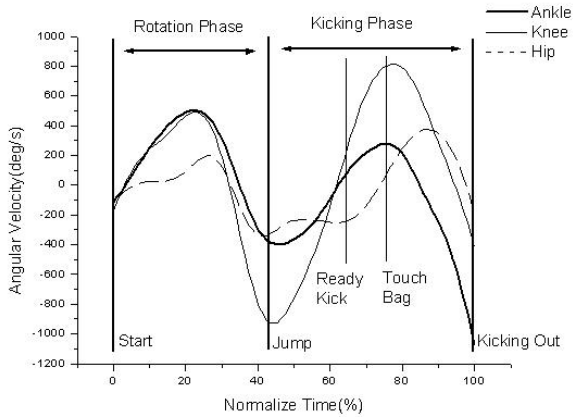

Figure 2: Angular Velocity of attack leg

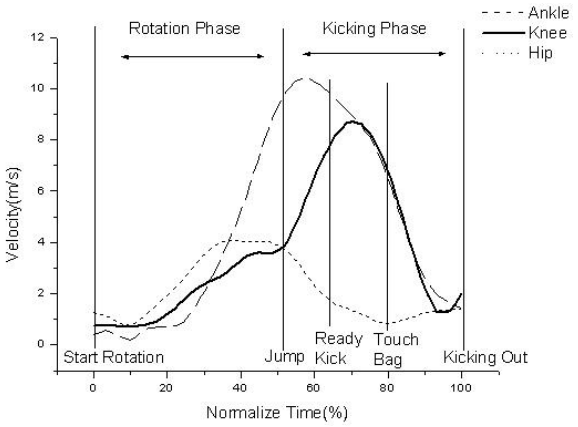

Figure 3: Linear Velocity of attack leg

When attack leg kicking, the angle of hip was still decreasing. The angle of knee and ankle joins of support leg was from extension to flexion in kicking phase (Figure 4). Seven subjects have the same trend, so the figure presented one of subject in this study. The GRF of support leg was the peak vertical force appearing before the peak horizontal force during rotation phase. The peak vertical force approximated 1.7 BW and the peak horizontal force approximated 0.4 BW (Figure 5). The GRF figure was average seven subjects GRF.

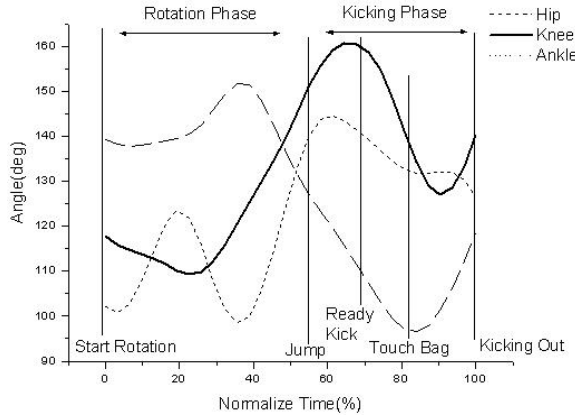

Figure 4: Angular Velocity of support leg

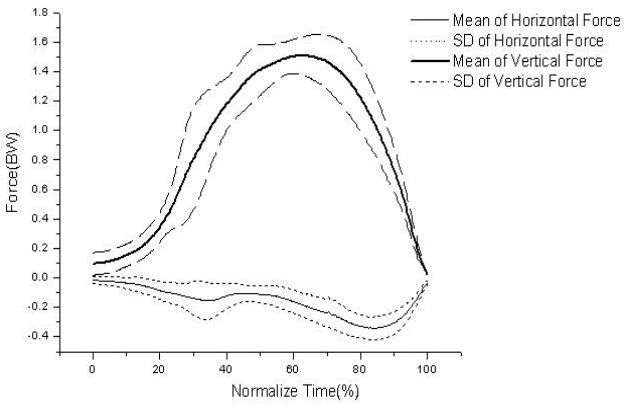

Figure 5: GRF of support leg

The peak vertical and horizontal GRF, impulse and total time of rotation phase showed in Table 1. When subjects kicked the bag, the height of center of mass approximated 24 cm, which was maximum high after jumping. The start rotation height, peak height, hit a bag height and jumping height was shown in Table 2.

Table1 The peak vertical and horizontal GRF, impulse and total time of rotation phase n=7

	Peak GRF (BW)		Total Impulse (N*S/kg)		Total Time(sec)
	Horizontal	Vertical	Horizontal	Vertical	Rotation Phase
M	0.35	1.71	0.044	0.261	0.29
SD	0.07	0.22	0.017	0.032	0.03

Table 2 The start rotation height, peak height, hit a bag height and jumping height n=7

	Center of Mass (cm)			
	Start Rotation	Peak Position	Hit to Bag	Jumping Height
M	77.73	102.57	101.35	24.84
SD	3.89	3.27	3.08	4.54

In rotation phase, the maximum displacement COP of medial-lateral reached to 64.7cm; On the other hand, the maximum displacement COP of anterior-posterior reached to 32.4cm. Figure 6 shows COP shifted displacement of medial-lateral during rotation phase. Figure 7 shows COP shifted displacement of anterior-posterior during rotation phase. The COP figure was average seven subjects COP.

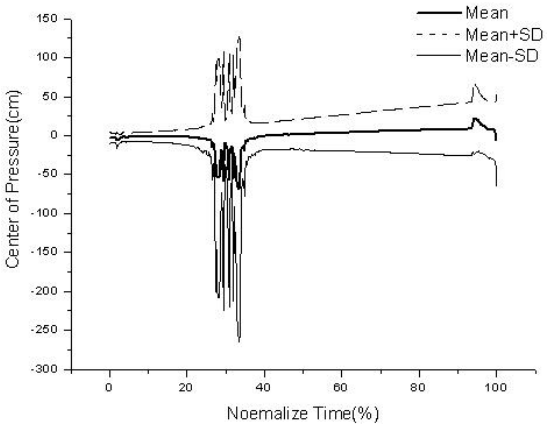

Figure 6: COP of medial-lateral

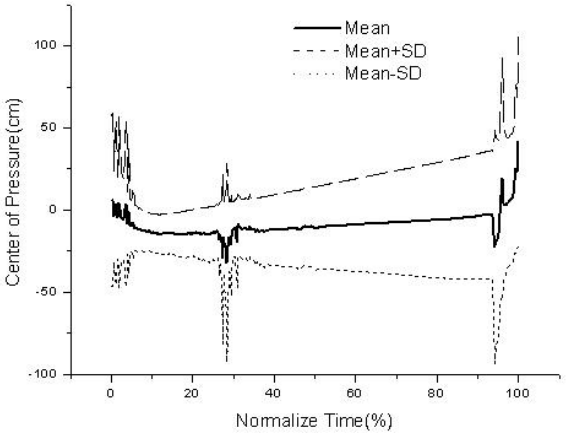

Figure 7: COP of anterior-posterior

DISCUSSION:

Back kick movement was open kinetic chain (Hong, 1996, Lee, 2007). Form attack leg joints' sequence dose not follows kinetic chain which from proximal to distal, P-D sequence. Although Hong (1996) analysis basis back kick which a support leg does not leave ground, also does not follow P-D sequence. Figure 2 and 3 show JBK attack leg angular and linear velocity in kicking phase. Therefore, Lee and Huang (2006) inferred to three back kick's pattern should the same. This statement obtained the scientific proof. The main contribution is extension knee joint and flexion ankle using heel to attack target during the attack phase. In the other hand, Lee (2007) considered the optimum jump back kick driving model is upper trunk, lower trunk, hip to knee. It mentioned that the hip and knee joint motion in the kicking phase which is important. In this study, whole subjects' hip were keeping extension during attack phase. It infers that this situation associated the weight level and training method. The flection and extension of hip and knee are noteworthy in pedagogy of back kick.

When support leg jump and leaving ground, the knee and ankle keep extension to ready kick and then flection prepare kick the bag and landing. After hit the bag, the hip of a support leg started extension (Figure 4). However, the hip angle was flection which associated with trunk posture. Thus, the trunk motion became a main factor of support leg movement, especially hip during kick phase. When subject hit a bag, the athlete was located on the peak position. The ready kick position can divided knee and ankle extension and flection. Meanwhile, center of mass height increased during contact phase. Before ready kick position, knee and ankle flection help jumping height. After ready kick position, knee and ankle extension maintain the whole segments balance, particularly hit a bag instant.

The powerful kicking of JBK, the rotation phase is important. From force plat data shows the peak vertical GRF approximated 1.7 BW and the peak horizontal GRF approximated 0.4 BW (Figure 5). The vertical force provided the jumping height. The horizontal GRF is worthy mentioned because all rotation progressive was braking phase. Following law of mechanics, the subject should jump back not forward motion direction. This situation has two reasons to explain. Firstly, when researcher check the video, each subject use toe to rotate the Figure 4 can obtain. The ankle is extension from 5% to 20%, then flection to 38%. Ankle extension again is preparing jump. Therefore, the toe did not push force on the ground. Secondly, the moment of inertia and center of mass has forward to the bag which infers to overcome opposite direction main reason.

As previously mentioned that the rotation mechanism. The COP can stand for the position of resultant force in force plat. When starting rotation and ankle extension, the displacement shifts dramatically in the medial-lateral direction. Nevertheless, other section is steady. By contract, the anterior-posterior direction, the COP shifting displacement has considerable individual different. It inferred the center of mass position trunk and ankle motion conduct this pattern.

CONCLUSION:

The linear and angular velocity indicated the sequence of attack leg joints was not following kinetic chain during kicking phase. When attack leg kicking, the angle of hip was still decreasing. The knee angle and ankle joins of support leg were from extension to flexion in kicking phase. The GRF of support leg was the peak vertical force appearing before the peak horizontal force during rotation phase. The COP measure the dynamic balance in rotation phase. When support leg utilized toe to rotate, the COP of medial-lateral had more displacement. However, the COP of anterior-posterior shifted forward and increased the displacement.

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