BIOMECHANICAL ANALYSIS OF BACK KICKS ATTACK MOVEMENT IN TAEKWONDO

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The purpose of this study is to compare three Taekwondo back kicks attack movements. Seven male Taekwondo athletes (age: 21.0 ± 2.0 year old, height: 180.4 ± 4.4cm, weight: 69.1 ± 26.1kg) performed the back kick, jump back kick and 360° jump back kick where the left leg was attack leg. Two Redlake (60Hz) cameras and an accelerometer were used to collect data. The results revealed that the jump back kick's attack force is greater than in 360° jump back kick. The angular velocity of knee and low trunk of back kick and jump back kick are faster than 360° jump back kick during rotation phase. The 360° jump back kick has a greater attack height and distance when striking the bag. The study suggests back kicking as important skill which the athletes need to practice for improving the kicking ability.

KEY WORDS: taekwondo, back kick, jump back kick.

INTRODUCTION: After Taekwondo became an official sports in Olympics, many coaches and athletes are devoted in Taekwondo match. Although round-house kick is frequently used in Taekwondo match (Roh & Watkinson,2002 ; Lee, Chin & Liu,2005), the back kicks are the best counterattack movement for round-house kick. In this movement's feature the athlete is back to the opponent and the attack leg passes by the support knee in a direct line to the target. The attacking area is the opponent's trunk. The faster trunk rotation and straight attacking in back kick can produce powerful attack force which often knocks the opponent down (Eddie,1989 ; Lee,1996).The jump back kick and 360°jumping back kick are derived from basic movement of back kick, and all three back kicks are the major offensive weapons in Taekwondo match. The purpose of this study is to compare three Taekwondo back kicks attack movements.

METHODS: Seven male Taekwondo athletes (age: 21.0 ± 2.0 year old, height: 180.4 ± 4.4 cm, weight: 69.1 ± 26.1 kg) participated in this study. Two Redlake (60Hz) cameras were genlocked to collect kicking movements. The Kwon 3D motion system was used to analyze the kinematics data. The model of body segment parameters was adopted by Zatsiorsky, Seluynov and Chugunova (1990). The accelerometer (CXL50LP3) was fixed on the bag (20 kg). Biovison system and DasyLab software were used to record acceleration value. The g value in the movement direction was defined as the attack force. There were three movements including basic back kick (BK), jumping back kick (JBK) and 360° jumping back kick (360°JBK) which are shown in Figure 1,2 and 3.

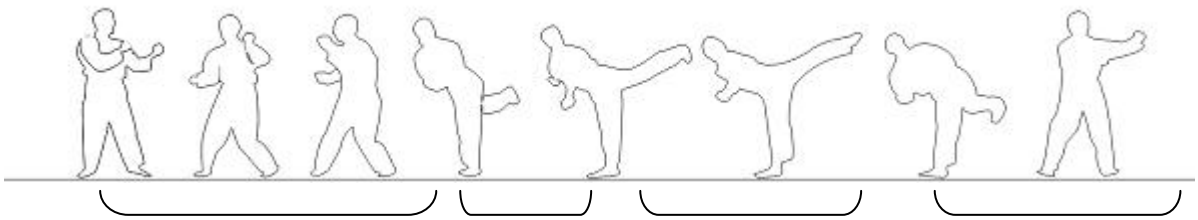

Figure 1 Illustration of Basic Back Kick

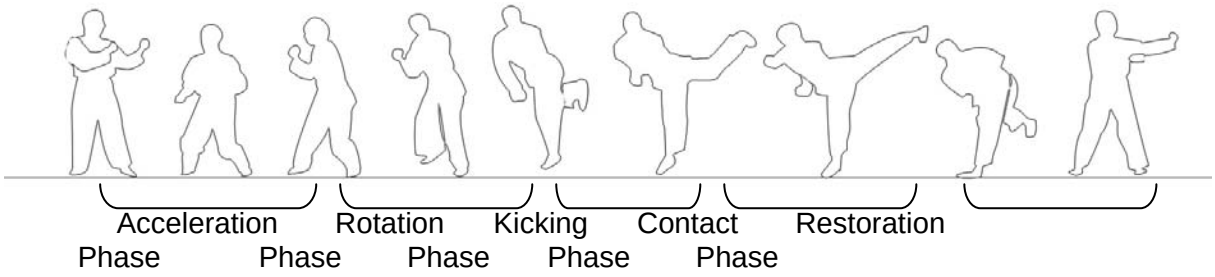

Figure 2 Illustration of Jumping Back Kick

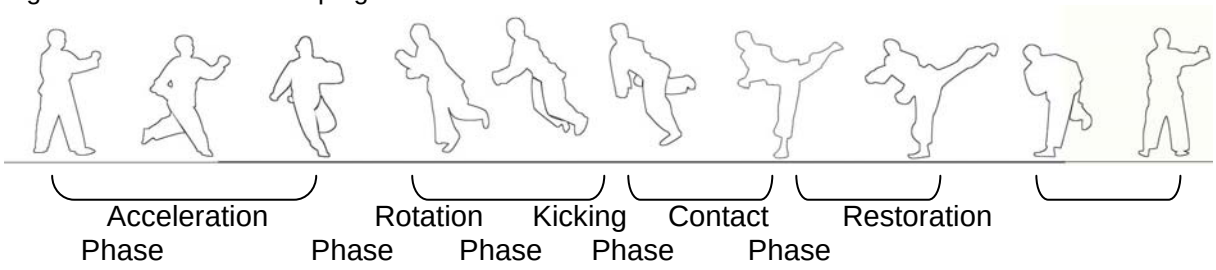

Figure 3 Illustration of 360°Jumping Back Kick

In this study, attack time is defined as the time of rear foot toe off the ground to attack leg heel contact the bag. The attack distance is defined as the horizontal displacement of rear foot heel at the ready position to the attack leg heel contact the bag. The attack height is defined as the vertical displacement of rear foot heel at the ready position to the attack leg heel contact the bag.

All movements are divided into the rotation, kicking and contact phase. Rotation phase was defined as the trunk start rotation to ready kick where the attack leg of thigh and shank became a minimum angle. Kick phase was defined as the minimum attack leg knee angle to contact the bag. Contact phase was defined as the period when the leg contacts the bag.

Each subject performed three trials for BK, JBK and 360°JBK.The greatest attack force was selected for analysis. The angular velocity, attack force and angular velocity of low trunk and extremities for the three phases were calculated from video and accelerometer.

Repeated measures one-way ANOVA was used to determine the differences for all parameters in three back kicks attacking movements. The LSD post hoc test was used for pair-wise comparisons. Statistical significance was set at 0.05.

RESULTS: Table 1 listed the acceleration, attack time, attack distance and attack height of three kicks. There are significant differences on acceleration between JBK and 360°JBK. The 360°JBK have significant larger attack height and distance than BK and JBK. However, the 360°JBK also has a significant longer attack time than BK and JBK

Table 1 Mean and standard deviation of acceleration, attack time, attack distance and attack height in BK, JBK and 360°JBK

	BK		JBK		360°JBK		
Measure	M	SD	M	SD	M	SD	F
Acceleration (g)	5.20	0.78	$5.74^{\#}$	0.78	$3.54^{\#}$	1.98	0.2*
Attack time(sec)	$0.66^{\&}$	0.05	$0.72^{@}$	0.10	$0.99^{\&@}$	0.14	24.0*
Attack distance(m)	$1.47^{\&}$	0.08	$1.53^{@}$	0.06	$1.69^{\&@}$	0.08	6.8*
Attack height(m)	$1.04^{\&}$	0.07	$1.07^{@}$	0.06	$1.21^{\&@}$	0.08	17.4*

*p＜.05 # significant then 360°JBK & significant then BK
@ significant then BK

Figure 4 shows the acceleration of BK, JBK and 360°JBK of one subject. The peak acceleration during bag impact for JBK is near 5.7g.

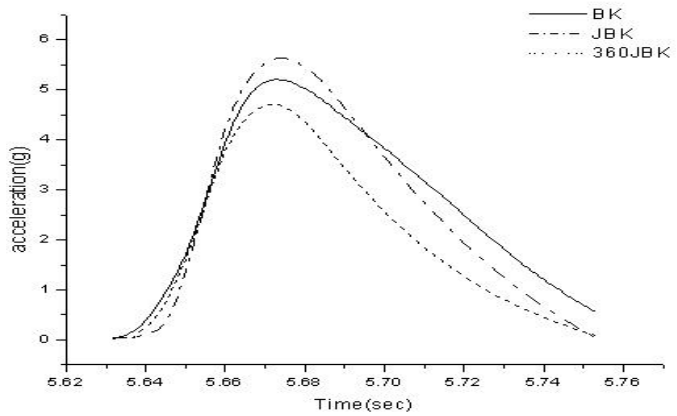

Figure 4 The acceleration of BK, JBK and 360°JBK

The angular velocities of low trunk and low extremities of three phases on three kicks are listed in Table 2. There are differences on angular velocities on rotation and contact phases but no significant difference on kick phase among three kicks.

Table2 Mean and standard deviation of kinematics data in BK, JBK and 360°JBK

Variable		BK		JBK		360°JBK		
		M	SD	M	SD	M	SD	F
Rotation Phase	Low trunk Angular Velocity (deg/s)	675.8^{+}	37.9	555.4$^{\#}$	27.9	449.9$^{+\#}$	52.6	6.7*
	Knee Angular Velocity (deg/s)	934.6^{+}	44.7	869.8$^{\#}$	35.8	342.1$^{+\#}$	20.1	92.8*
Kick Phase	Knee Angular Velocity (deg/s)	954.7	66.0	942.1	39.9	808.6	51.5	2.2
	Ankle Angular Velocity (deg/s)	210.4	38.2	219.2	28.2	122.9	45.0	1.4
Contact phase	Knee Angular Velocity (deg/s)	952.8	186.6	944.2	236.9	843.8	158.3	0.9
	Ankle Angular Velocity (deg/s)	547.6	279.1	348.3	230.2	451.9	226.5	1.2

*p＜.05 $^{+}$ significant then 360°JBK $^{\#}$ significant then 360°JBK

DISCUSSION: The result shows BK and JBK have a higher attack force than 360°JBK at bag impact. The smaller attack force for 360°JBK is due to the support leg and the attack leg is the same leg and a highly demand skill for full turn in the air before the bag impact which may decrease the impact force. The rotation phase is very important for back kicks, especially in low trunk rotation (Park &Seabourne, 1997).

The BK and JBK low trunk angular velocity was faster than 360°JBK during the rotation phase. The reason is that BK and JBK use the support leg to help the body turn backward before the kick which may increase the low trunk angular velocity during the rotation phase. The BK and JBK also have faster attack leg knee angular velocities than 360°JBK during the rotation phase. The faster knee angular velocity may relate to attack leg take off ground and quick flex the knee prepare for kicking. However, the 360°JBK uses the attack leg take off to preparing for jump full turn which could decrease the knee angular velocity during the rotation phase. There is no significant difference on knee and ankle angular velocity during

the kick and contact phase among the three back kicks. The 360°JBK has significant greater attack height and attack distance than the BK and JBK. In Taekwondo match, a great attack height or attack distance has the advantage over the opponent. However, the 360°JBK also has longer attack time than BK and JBK which is a disadvantage in competition.
In Taekwondo match, using the back kicks you have to combine the strategy. JBK is the main counterattack movement especially when the athlete faces the opponent. The faster angular velocity of low trunk and knee at rotation phase of JBK help shorten the attack time. JBK has a powerful attack force and a high percentage of successful rate to striking the opponent down when attack in the right timing. The 360°JBK is an active movement which usually follows some kick or pseudo movement and can develop the effect offensive. The 360°JBK is divided into two actions which increase the attack time and attack distance. First, the swing leg rotates forward which test and break the opponent´s rhythm. Second, jumping attack which often attacks the opponent´s head because the 360°JBK has a greater attack height. The 360°JBK is a complicated and demanding higher jumping ability and agility which is used by under Feather class athletes in the match.

CONCLUSION: The purpose of this study is to compare three Taekwondo back kicks. The timing of rotation phase in back kicks which contribute a greater attack force for BK and JBK, attack time, distance and height would influence the application of the three back kicks in strategy. However the 360°JBK has a great attack height and distance when striking the bag. The correct timing of attack is very important for back kicks. The back kicks are important attack skills in Taekwondo match which need more research in order to understand the techniques.

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