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ROTATION MOVEMENT ANLYSIS IN TAEKWONDO POWER BREAKING MOVEMENT OF 360° JUMP BACK KICK

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The purpose of this study was to investigate reaction force of both legs of 360° jump back kick in Tawkwondo. Eight Taekwondo coaches (Height: 175.7±5.7cm; Weight: 75.0±7.9kg; Age: 28.0±4.2years) performed this kick movement to break one inch board. The equipment included ten Vicon cameras (MX13+, 250Hz) and two Kistler force platforms (1000Hz). Kinematic and kinetic data were collected by Nexus software. All variables were calculated by custom written program of MatLab. The results showed that the swing leg provided the push force allowing the axis leg to rotate in rotation phase. The axis leg not only relied on the vertical GRF and impulse obtaining jumping height and moving distance but its joints angle change also balanced the entire body. In conclusion, the interaction of both legs in start-up phase as well as the posture of axis leg during in rotation phase determined the rotation motion of 360° jump back kick in Taekwondo.

KEY WORDS: 360° JUMP BACK KICK, BREAKING BOARD, ROTATION.

INTRODUCTION:

Taekwondo is now not only having traditional competitive marches also promoting “Poomsae” which emphasize on personal skills. Breaking a board is utilized for testing personal kicking motions and the ability of force control. The 360° jump back kick is a complex motion which included rotation, jump and kick (Lee and Huang, 2006). Lee and Huang (2010) discovered two points in this motion that A) the attack leg did not follow the kinetic chain. B) both lateral and vertical displacements had slightly change from prepare to kicking phase and was from prepare to rotation phase, respectively. Fewer studies focus on the rotation movement in Taekwondo. The purpose of the study was to investigate the ground reaction force (GRF) between both legs and the rotation motion of the 360° jump back kick.

METHOD:

Eight Taekwondo coaches, who have promoted to the 5th Dan above, (Height: 175.7±5.7cm; Weight: 75.0±7.9kg; Age: 28.0±4.2years) performed the kick movement to break one inch board five times. Before each coach broke a board, the boney landmarks were attached. The segment coordination was defined by ISBS recommendation (Wu, 2003). They stood each leg on two Kistler force platforms (1000Hz). The marks were traced by ten Vicon cameras (MX13+, 250Hz). Kinematic and kinetic data were collected by Vicon Nexus software. All variables, angles of the axis leg, GRF and impulse of vertical and horizontal directions, were calculated by custom written program of MatLab. The body segment parameters were adopted by Winter (1990). Angle and angular velocity of the axis leg were calculated by Euler angle. GRF was standardized by body weight. This essay only analyed this motion from star-up to rotation phase.

The 360° jump back kick in Taekwondo was divided six phases, prepare, step, push, rotation, kicking and contact phase (Figure 1). The swing leg is defined as the back leg in the ready position. The axis leg is defined as forward leg in the ready position. Start- up phase is defined as from ready position to the swing leg leaving the ground, which included prepare, step and push phases. Prepare phase is defined as from ready position to the axis leg leaving the ground. Step phase is defined as the axis leg from leaving the ground toward to return the ground. Push phase is defined as the swing leg pushes the ground since the axis leg back the ground. Rotation phase is defined as the axis leg becoming the leg on the ground and the swing leg leaving the ground leading whole body rotating toward until the axis leg jumping

from the ground. When the axis leg jumps, it becomes the attack leg. Kicking phase is defined as the process of the attack leg breaking a board in the air. Contact phase is defined as attack leg when knee bending to minimal angle, which is ready kick, and then knee extension to break a board.

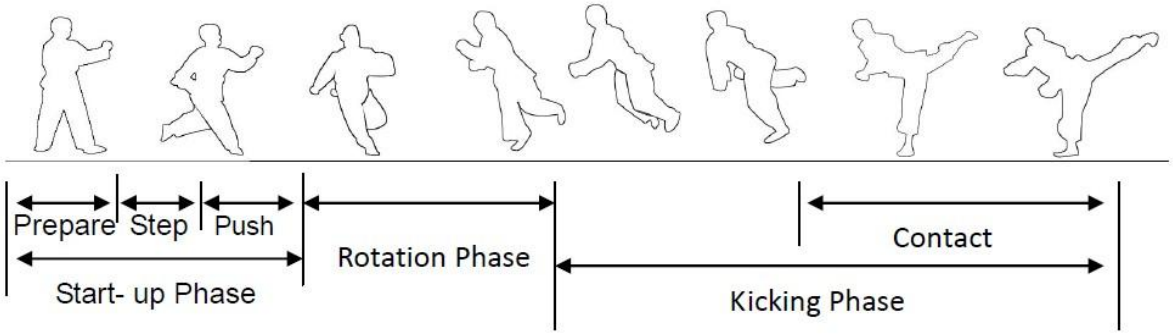


Figure 1 Illustration of 360°Jumping Back Kick

RESULTS:

The total time is that a subject is rotating on the force platforms before leaving the ground. Setting the total time from start-up to rotation phase was 100%, the peak GRF and its timing of both legs (Table 1& 2). The force was normalized by the body weight of each subject.

The impulse from push phase to rotation phase contributed in the vertical and horizontal direction. (Table 3). The impulse was calculated by normalized GRF multiplied the experienced time of its leg staying on the force platform.

Table 1 Peak GRF, time of peak GRF of the swing leg and total time of the movement n=40

	Peak GRF (BW)		Time of Peak Value (%)		Total Time (sec)
	Vertical	Horizontal	Vertical	Horizontal	
Mean	1.68	0.12	48.40	55.89	0.42
SD	0.36	0.07	10.39	28.67	0.19

Table 2 Peak GRF, time of peak GRF of the axis leg and total time of the movement n=40

	Peak GRF (BW)		Time of Peak Value (%)		Total Time (sec)
	Vertical	Horizontal	Vertical	Horizontal	
Mean	2.29	0.26	66.13	77.24	0.42
SD	0.37	0.22	6.16	16.01	0.19

Table 3 Impulse from push phase to rotation phase n=40

	Rotation Phase			Push Phase			Total Time (sec)
	Impulse of the Axis leg (N*s)			Impulse of the Swing leg (N*s)			
	Vertical	Horizontal	Time(%)	Vertical	Horizontal	Time(%)	
Mean	212.73	43.46	47.10	92.00	7.96	9.00	0.42
SD	140.36	41.81	30.14	50.09	5.62	3.93	0.19

The pattern of force distribution and of the interaction between both legs could be seen from GRF (Figure 2). The time was normalized by a subject staying on the ground. Moving to rotation phase, the angle change of hip, knee and ankle on the axis leg (Figure 3) could explain how subjects maintain the dynamical balance. The time here was normalized by a subject performing entire movement.

Figure 2 GRF reaction during support phase

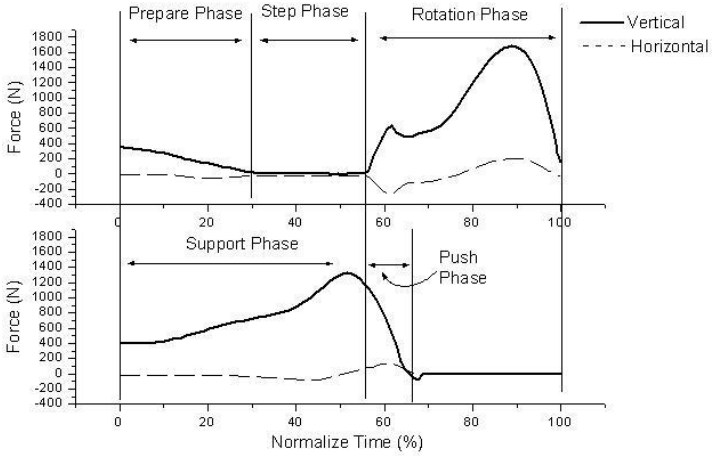
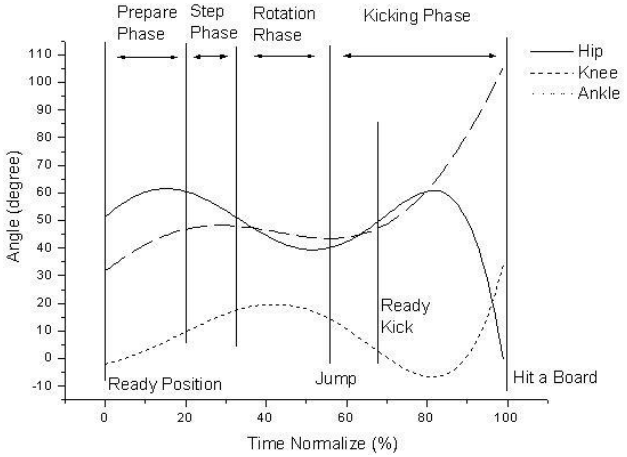


Figure 3 Angle change of the Axis leg



DISCUSSION:

From the GRF data in each platform, while axis leg took a step forward, swing leg was supporting the entire body weight. When axis leg returned to the ground, swing leg prepared to push ground and the GRF reached a peak in the vertical direction. Then, the peak horizontal GRF appeared, centre of mass (COM) of body was moving to the axis leg for rotating by the momentum from swing leg in push phase. Looking at the peak GRF of vertical and horizontal direction, the axis leg jumps from the ground.

In this complex kick movement and board broken, the stable displacement of COM is very important. Lee and Huang (2010) showed the stable displacement of COM in lateral direction almost remained the same level which means the entire body stabilizes moving to the target with rotation, jumping, and kicking as well as the same situation also happened in the vertical direction before the jump off the ground.

Before subject jumping, the shifting between two legs is noted. In the early rotation phase, two legs are double stance. Swing leg pushed the ground in order to provide a force allowing the whole body to rotate. Then, swing leg was swing for maintaining dynamic balance. Regarding to the angle of axis leg in the rotation phase, the angle of knee and ankle flexed and almost fixed in a certain angle after a step during the rotation phase. Only the hip angle kept flexion in this phase. When axis leg jumped off the ground to ready kick motion, hip, knee and ankle were extension. The foot was close the target; ankle was flexion because subject used the heel to break the board. Knee still extended which is main contribution to strike the board.

Turning to contribution of impulse between vertical and horizontal directions, vertical push impulse in the swing leg gives an initial force from the ground and speed which results in a body rotating toward. The impulse in the axis leg of rotation phase contributes a jumping height and a moving distance during kicking phase.

CONCLUSION:

Rotation movement of 360° jump back kick in Taekwondo has two main factors. One is that the interaction of both legs and force implementation to the ground which produces rotation speed and maintains dynamic balance during the rotation phase. Furthermore, motion of the axis leg needs to manipulate properly. Each joint's extension and flexion before jump will influence the following motion and the board could be broken.

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