P04-17 ID170

TAEKWONDO BACK KICK KINEMATICS OF ELITE AND YOUTH ATHLETES

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The purpose of this study was to analyze taekwondo back kick kinematics of elite and youth athletes. The athletes were instructed to perform basic back kick ats the target with their dominant leg. 3D motion analysis system was captured three back kicks at the sampling rate of 100 Hz. Response time was also recorded. The Mann-Whitney U test did not reveal significant differences of selected kinematics and temporal variables of back kick between two groups. Both athlete groups show similar kicking pattern. Peak linear velocity occurs prior to the impact. Peak kicking velocity should occur near the impact. Nevertheless, this study only investigated static simple back kick. Future research should investigate different types of back kick.

KEY WORDS: Kinematics, Back Kick, Taekwondo, Response Time

INTRODUCTION: Although roundhouse kick is the most common of kicking to score but the back kick is the best counter attack for round house kick (Kazemi et.al, 2010, Lee et.al, 2006). The effective of this kick require the precision of timing and have a speed such as angular velocity of lower limb joints and rotation the body turn backward before kicking (Lee et.al, 2006; Kim et.al, **2011)**. Although kinematic charactersitics of back kick not have been the research to compared back kick between adult and youth taekwondo atheletes. Thus, the purpose of this study was to examine back kick kinematic differences between elite athletes (EA) and youth athletes (YA).

METHODS: Six elite taekwondo athletes (age: 21.6$\pm$1.9 years old, weight: 56.4$\pm$6.8 kg, height: 167.3 $\pm$ 4.9 cm) and six youth taekwondo athletes (age: 16.3$\pm$1.2 years old, weight: 60$\pm$13.6 kg, height: 172.8$\pm$10.2 cm) participated in this study. The elite group participated in the international competition (Olympic game, World taekwondo championships, etc.). Nineteen retroreflective markers were attached to the following landmarks: sacrum, left and right acromion processes, greater trochanters, femoral wands, lateral epicondyle of femurs, tibial wands, lateral malleoli, 5^{th} metatarsal joints and heels. Each subject was instructed to perform three basic back kicks to the target with their dominant leg. The distance and the height of the target were self-selected. Kicking motion was recorded by eight optical cameras at the sampling rate of 100 Hz (Natural Point Inc., USA). The raw coordinate data were exported in c3d format. The bodybuilder was used to analyze lower limb joint kinematic data based on Vaughan's model (Vaughan et al, 1999). The 5^{th} metatarsal joints was used to determine foot velocity. Additionally, response time was measured with mounted LEDs above the target. The Mann-Whitney U test was employed to determine statistically significant differences between the two groups (p<0.05).

RESULTS: The back kick is commonly divided into 4 phases: Rotation, Kicking, Contact and Restoration phases (Lee et al, 2006). However, this study was focused only the first 3 phases. Temporal variables of kicking were showed in the Table 1. The back kick motion was time normalized from the starting until the impact. The rotation phase was the longest whereas the kicking phase was the shortest. Peak linear velocity of the foot of EA (8.86 $\pm$ 0.93 m/s) was greater than YA (8.36 $\pm$ 1.6 m/s), but no significant difference was found. Additionally, kicking velocity was decreased until impact (Fig 1). The mean angular displacements and velocities of hip and knee of both groups were showed in Figure 2. Peak angular velocities of all three

joints were found in kicking phase (Table 2). No significant differences between the two groups were found ($p < 0.05$).

Table 1
Temporal Variables between groups

Kicking Phase	EA	YA	P-value
Rotation Kicking	0.64 ± 0.07 (71.8%)	0.58±0.05 (69%)	0.09
MHF	0.12 ± 0.01(15%)	0.11±0.01 (15%)	0.46
HEX	0.10 ± 0.04 (12.6%)	0.11±0.01 (15%)	0.57

MHF: Maximum hip flexion; HEX: Hip extension

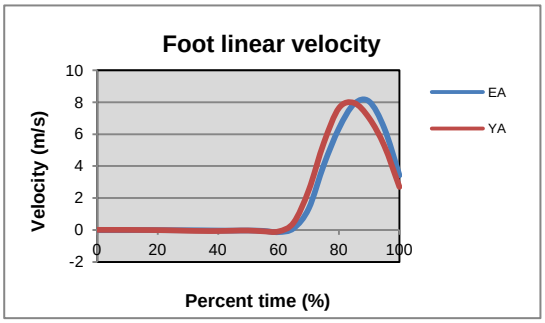

Figure 1 Linear foot velocities

Table 2
Mean ± SD of selected angular kinematic variables of back kick

Kinematic variables		EA	YA	*p-value*
Max Hip ang vel (deg/s)	Flex/Extension	-379.1±139.0	-360.6±60.9	0.75
	Abd/Adduction	422.5±36.8	369.3±46.4	0.05
	Int /Ext Rotation	266.8±105.6	373.1±176.4	0.33
Max knee ang vel (deg/s)	Flex/Extension	715.0±53.5	672.1±43.7	0.22
Max ankle ang vel (deg/s)	Dorsi/Plantar Flexion	189.3±85.5	353.8±249.0	0.15

DISCUSSION: The result shows the rotation phase was the longest kicking phase. This phase starts from subject saw the LEDs turn on and then rotates the body backward just prior to toe off. In this phase, ahtletes requires not only fast response time but also a good balance and great rotational speed. Kim et al. (2011) reported faster response time (0.75 s) and greater kicking linear velocity (11.5 m/s) of back kick as compared to this study. Peak linear velocity was found in kicking phase during MHF and HEX events. Although it was not significant difference, YA reached the peak linear velocity slightly before the EA and continuely decreased until the impact. This is similar to the previous study which found peak linear velocity decreased just prior to imapct (Kim et al., 2011). Decreased linear velocity may be because athletes tried to control a foot to a target. Maintaing linear velocity prior to impact may be the key of effective kicking. Interestingly, knee angular displacement around impact position of YA was 20 degrees greater than EA. On the contrary, YA has hip flexion 10 degrees greater than EA. As a result, this could be compromized foot velocity. The highest knee angular velocity was found in this study which was lower than the previous report of Lee et al. (2006). During HEX, atheltes of both groups extended and abducted their hips and simultaneously extend their knees.

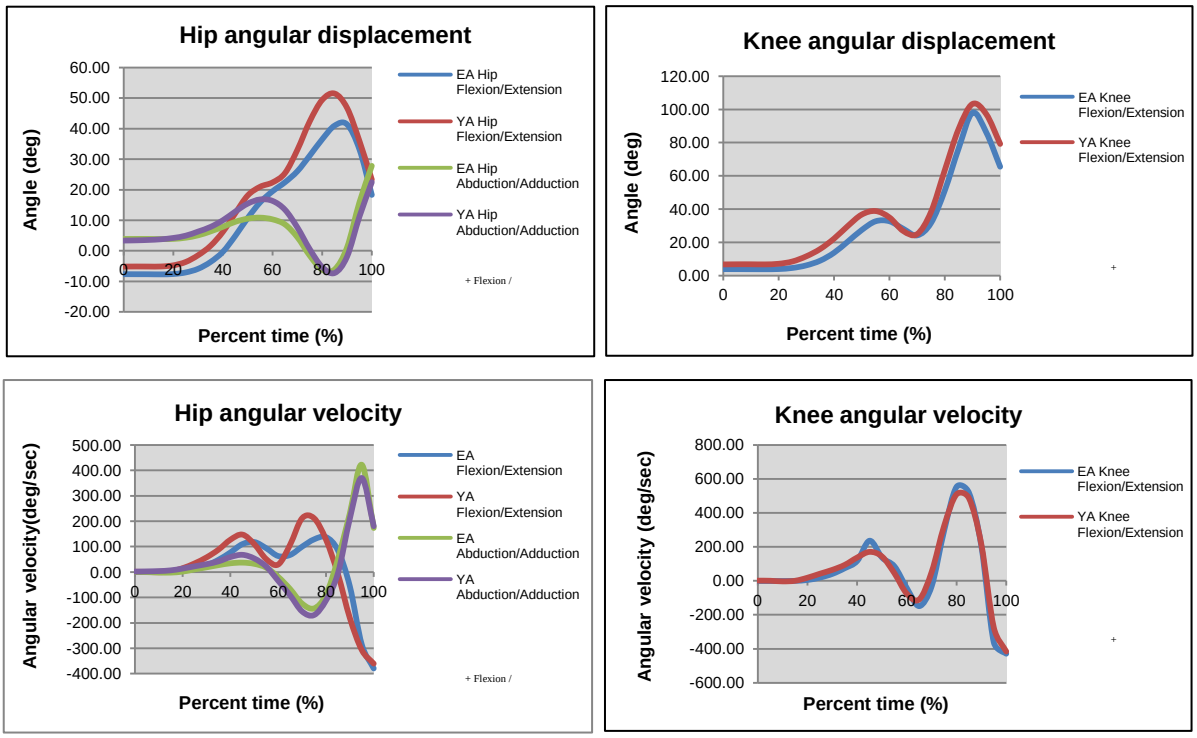

Figure 2: Joints angles (top) and angular velocities (bottom) of hip and knee

Although hip abducted angular velocity was not significantly, the EA group showed higher angular velocity than the YA group. One of interesting is that peak ankle angular velocities of both groups in this study did not occur at the impact. Unlike the previous study, Lee et.al (2006) reported peak ankle angular velocities of back kick during contact phase (547.6 deg/s). This is may be due to ankle dorsiflexion before foot contacting the target. Even though ankle angular velocity is not effect overall kicking velocity, it may effect the impact force. Nevertheless, this study did not measure imapct force. The results of this study do not find any differences between the two groups which may be due to a small sample size. Additionally, only static back kick was performed in this study. Therefore, future studies should investigate different kinds of back kick with a larger sample size. Inter-segment coordination may also need to be investigated.

CONCLUSION: Elite taekwondo athletes and youth athletes exhibit similar kinematics pattern of simple back kick. Kicking velocity is derived from several factors including body angular rotation, hip and knee motion. However, greater hip flexion during kicking phase may reduce kicking velocity. The most effective kicking should maintain high peak velocity just before the impact.

REFERENCES:

Kazemi, M., G. & Perri, et al. (2010) A profile of 2008 Olympic Taekwondo competitors. *Journal of Canadian Chiropractic Association*

Kim, Y. K., Kim, Y. H. & Im, S. J. (2011) Inter-joint coordination in producing kicking velocity of Taekwondo kicks *Journal of Sports Science and Medicine*, 10, 31- 38.

Kim, Y. K. & Kim, Y. H. (2011) Taekwondo biomechanics: intersegmental joint coordination and hopping effect. *In KSIAM 2011 Spring Conference*, Jeonmin-Dong, Yusung-Gu, Daejeon, Korea.

Lee, C. L. & Huang, C. (2006) Biomechanical analysis of back kicks attack movement in Taekwondo. *In Proceedings of the XXIV International Symposium on Biomechanics in Sports (ISBS)*, Salzburg, Austria, 1-4.

Vaughan, C.L., Davis, V.L. & O' Connor, J. C. (1999) *Dynamics of Human Gait* (2nd edition), Kiboho Publisher, South Africa

Acknowledgement

This research project was supported by Sports Authority of Thailand.