KINEMATICS ANALYSIS OF TAEKWONDO'S RELATIONSHIP BETWEEN ROUNDHOUSE KICK VELOCITY AND ELECTRONIC BODY PROTECTOR

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The purpose of this study was to investigate the influence of kicking velocity on inductive values of electronic body protector during a roundhouse kick. Six elite collegiate taekwondo player participated in the study. Each participant performed five 90°roundhouse kick as hard as possible and record the inductive values of electronic body protector. Kicking velocity of kicking leg was measured by motion analysis system. The results showed that kicking velocity before impact of the highest scoring kick was significantly higher than that of lowest scoring kick. In addition, impact kicking velocity of the highest scoring kick was significantly higher than that of the lowest scoring kick. In conclusion, inductive values of the electronic body protector were increased by improving kick velocity at the moment of foot contact.

KEY WORDS: Daedo, highest scoring kick, lowest scoring kick.

INTRODUCTION: Taekwondo is a game that requires speed and accuracy. In the past, Taekwondo was scored by four referees based on visual and auditory judgments. There are many disputes in determining the score. In order to maintain a fair competition, the electronic equipment scoring system was used in global-champions. Electronic body protector (EBP) with a pressure sensing element can produce the judgments of score. Therefore, it has become an important issue to explore the influence of kicking technology on the electronic body protector. Previous study found that getting the effective score is difficult for kicking the surrounding position of Daedo's electronic body protector. The central position of the electronic body protector is great target position for high score of EBP (Chang, J. S et al, 2017). On the other hand, the Daedo's electronic body protector has a large frontal area than two side, which allows a larger force and more accurate for roundhouse kick. This results suggests that the frontal position of electronic body protector could get higher scoring opportunities than two sides of electronic body protector (Chang, J. S et al, 2017). In addition, different kick angle can influence inductive values of Daedo's electronic body protector. The results showed that the 90°roundhouse kick had a greater electronic sensor scores than 60° kick and the 30° kick (Chang, J. S et al, 2017). These results show that the scores of EBP are affected by different kick techniques. When we asked the taekwondo's player to perform five 90° roundhouse kicks, we also have found that the electronic sensor score can produce a large sensor score but it does not get a high scores for every kick. Even if the taekwondo's player kicks the electronic body protector in the same way, the score of EBP may be different. According to the application of momentum in Taekwondo, the high kicking velocity can produce greater momentum (Lin, J. F, 1999). Therefore, we hypothesize that the inductive values of the EBP may be related to the kicking velocity. To test this hypothesis, we measure whether or not that the inductive values of the EBP were significantly different for highest scoring kick and lowest scoring kick in the five 90° roundhouse kick. Further,we explored whether or not that the highest value of EBP result from fast kicking velocity.

METHODS: Six elite collegiate taekwondo players participated in the study. The experiment was set up on a standard taekwondo court. Each participant performed five 90°roundhouse kick as hard as possible. Kicking foot must to contact the central area of the electronic body protector. This study used WTF approved Daedo brand electronic body protector. The system includes electronic chest protectors, electronic socks, signal transmitters, signal receivers, and scoring system interfaces. Kicking velocity was measured by motion analysis system. Motion Analysis System with 8 Eagle Digital infrared high speed cameras at 200 Hz

were used (Motion Analysis Corporation, Santa Rosa, USA), and 43 reflective markers were placed on each participant and the electronic body protector to capture the velocity of lower limbs during the roundhouse kick. A global reference system was defined using standard convention with the positive X-axis in line with the protective gear, and the positive y-axis parallel to the protective gear, the positive z-axis pointing vertically. The 90°roundhouse kick was defined as the period from the onset of toe-off to target contact (Fig 2). All results are expressed as the mean±SD. Paired student's t-test was used to test the significant difference in this study and *p* value < 0.05 was considered significant.

RESULTS: In order to measure whether or not the values of electronic body protector were significantly different, the highest scoring kick was compared with the lowest scoring kick in the 90° roundhouse kick. The results showed that inductive values of the highest scoring kick (*M* = 55.17) were significantly higher than inductive values of lowest scoring kick (*M* = 47.33) (Figure 1).

The study further explored whether highest value of EBP result from fast kicking velocity. The kicking velocity was defined as the magnitude of the resultant linear velocity of the toe marker of the kicking leg (Figure 2). We examined the peak kicking velocity during kicking, kicking velocity before the moment of contact and the impact kicking velocity at the moment of foot contact. The results showed that kicking velocity before impact of the highest scoring kick (11.67) was significantly higher than that of lowest scoring kick (9.41). On the other hand, impact kicking velocity of the highest scoring kick (8.79) was significantly higher than that of the lowest scoring kick (6.52) (Table 1).

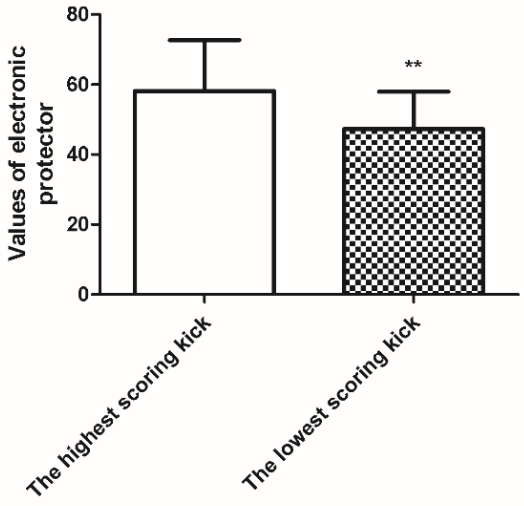

Figure 1: Inductive values of the electronic protector during highest and lowest scoring roundhouse kicks (mean±SD, **p<0.01).

Table 1: Comparison of kinematic variables in the highest/lowest scoring kick.

	The highest scoring kick	The lowest scoring kick
kicking time (s)	0.27±0.03	0.29±0.00
Peak kicking velocity (m/s)	13.30±1.05	12.14±0.39
Kicking velocity of before the moment of contact (m/s)	11.67±1.45	9.41±2.11**
Impact kicking velocity (m/s)	8.79±1.61	6.52±1.81**

mean±SD, **p < 0.01

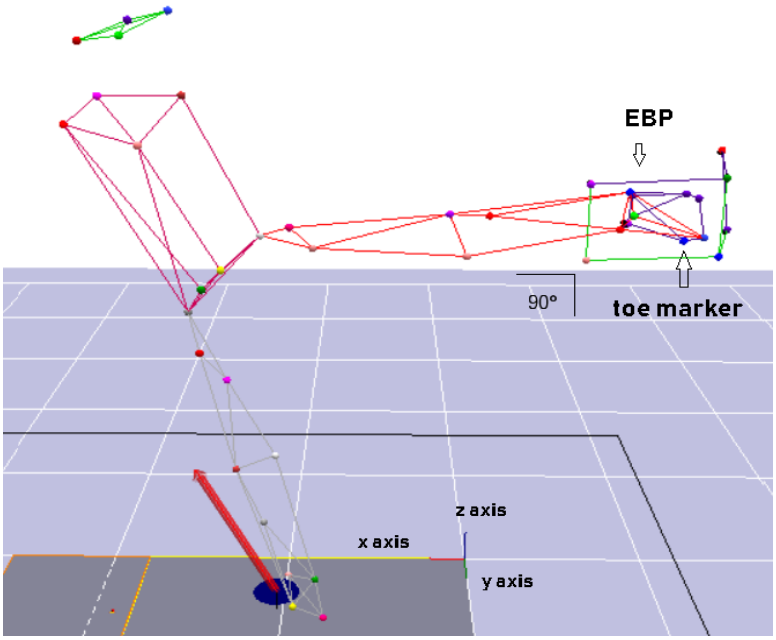

Figure 2: Cortex motion capture of the 90° roundhouse kick.

DISCUSSION: The electronic body protector can provide good objective values for score, but it is unknown that kicking velocity affect the value of electronic body protector. The purpose of this study was to investigate the influence of kicking velocity on inductive values of electronic protector during a roundhouse kick. In this study, kick target was set the central position of the electronic body protector, because the kicking position of the electronic body protector can influence values of Daedo's electronic body protector. In addition, all subjects was asked to execute 90° roundhouse kick, becaues the kicking angle of the electronic body protector can affect values of Daedo's electronic body protector (Chang, J. S et al, 2017). According to Taekwondo rule, the Daedo's value is above 42 it will objective definitely effective score. Although the average values of highest and lowest score kicks is over the score threshold, values of electronic body protector were significantly different. Our study found that the highest value of the electronic body protector resulted from fast kicking velocity. Kicking velocity before impact and impact kicking velocity of the highest scoring kick were significantly higher than that of lowest scoring kick. However, peak kicking velocity were not significantly different for highest and lowest scoring kicks. Thus, the impact kicking velocity proved to be a good momentum for the electronic body protector. These results suggest that raising the velocity of contact with the electronic body protector is important to getting high scores.

CONCLUSION: High kicking speed in Taekwondo is an important factor for winning games. Inductive values of the electronic body protector were increased by improving kick velocity at the moment of foot contact. This study can help coaches provide training and practical strategies in Taekwondo.

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