Effects of Rhythmic Hop on Response Times and Kicking Velocities of Taekwondo Kicks

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ABSTRACT

Most athletes execute rhythmic hop as a preparatory motion in Taekwondo sparring. The purpose of this study was to investigate the effect of rhythmic hop on the response times and kicking velocities of Taekwondo kicks. Twelve male elite Taekwondo athletes performed a roundhouse kick and a back kick as fast as possible immediately after seeing an external stimulus in rhythmic hop and in no hop, respectively. The three-dimensional marker data of the whole body were measured at sampling rate of 200 Hz. Paired t-tests were used to compare dependent measures between hop and no hop conditions. Results indicated that the rhythmic hop did not affect response time statistically but improved the kicking velocity significantly than no hop did. Different instants of detecting an external stimulus in rhythmic hop for the back kick showed significantly different response times. Conclusively, rhythmic hop is recommendable for the purpose of kicking velocity, but not for the purpose of response time. Athletes should be careful in executing rhythmic hop as their preparatory motions for the back kick, since the response time could be shortened or lengthened according to the instant of detecting an external stimulus.

Keywords: Response Time, Kicking Velocity, Rhythmic Hop, Taekwondo

I. Introduction

Taekwondo, as a combat sport in Olympic Games, requires rapid response to an external stimulus and fast kicking velocity for winning a competition. A shorter response time may allow a kicker to perform intended attacks successfully to obtain points as well as a faster kicking velocity may allow a kicker to give a strong impulse on an opponent. Thus, previous studies on the Taekwondo kick have primarily focused on the response time, the movement time, or execution time (Boey & Xie, 2002; Falco et al., 2009; Hermann, Scholz, Vieten, & Kohloeffel, 2008; Nien, Chuang, & Chung, 2004; Pieter & Heijmans, 2003; Shiang & Chou, 1998; Tang, Chang, & Nien, 2007) and the kicking velocity (Shiang & Chou, 1998; Tang et al., 2007) of the roundhouse kick which is the most popular kick in Taekwondo sparring. The response time is defined as the time difference from the instant of an external stimulus to the impact of kicking, which included reaction time and movement time together (Kim, 2010).

In some sports requiring a rapid response time, a preparatory motion (pre-movement) before executing a goal-directed movement has improved the quality of the movement (Uzu, Shinya, & Oda, 2009). In Taekwondo sparring most athletes practically use rhythmic hop as a preparatory motion while they are waiting for attacks and dodging in response to an opponent's action. This rhythmic hop is performed by repeatedly flexing and extending the hip, knee, and ankle joints slightly while remaining in the same place on the floor. Since rhythmic hop mechanically induces a prestretch potentiation of leg muscles (Aura & Komi, 1986; Bosco, Komi, & Ito, 1981) and functional stretch reflex (Melvill-Jones & Watt, 1971) in stretch-shortening cycle, it may affect the quality of the kicking movement to a certain extent than no hop does.

According to personal interviews with elite athletes, some of the elite athletes do not execute rhythmic hop intentionally in sparring because they believe rhythmic hop would be detrimental to response time in some defensive situations. However, no scientific investigation has answered this question.
The primary purpose of this study was therefore to investigate the effect of commonly-used rhythmic hop on the response times and kicking velocities of two Taekwondo kicks. Two kicks were the roundhouse kick and back kick, which represent popular techniques in Taekwondo sparring for the purposes of attacking and counterattacking (Figure 1). The second research question was to explore whether response time for a goal-directed kick depends on the instant of detecting an external stimulus in rhythmic hop.

II. Methods

1. Participants

Twelve male collegiate Taekwondo athletes (age 20.4±8.4 yrs, mass 71.9±8.4 kg, height 1.80±0.04 m) participated in the study. All of the participants have been practicing Taekwondo for more than seven years (10.6±3.2 yrs) and all have black belts of the 4th Dan and above. Participants reported no neurological and musculoskeletal deficits at the time of data collection. All participants signed a written informed consent form, and the study protocol was approved by the ethics committee of the University.

2. Experimental Setup

Full body kinematics, sampled at 200 Hz, was obtained using a six-camera motion tracking system (Hawk® Digital Real Time System, Motion Analysis System, USA; Figure 2). A 15-component link-segment model, consisting of 40 reflective markers, was used to estimate the location of the body CM based on the estimated body segment parameters (De Leva, 1996), and to quantify the motions of lower extremities. Those markers were attached on the following anatomical landmarks of both limbs, trunk, and head: toe, heel, medial and lateral malleolus, medial and lateral femoral condyles, thigh, shank, anterior superior iliac spine, poster superior iliac spine, acromion process, medial and lateral epicondyles, medial and lateral styloid processes, hand, upper arm, and head. The toe and medial markers in upper and lower limbs were removed after a static trial to facilitate dynamic kicking movement.

A hand-held pad (All-Star® Tae Hwa Sports, Korea), having one reflective marker on it, was used as the target. Movement of the marker was used to determine the onset of foot contact to the target. An assistant held the target with one hand, and with the other hand, held a custom-made red light-emitting diode (LED) close to the target (Figure 2). A custom-made LED was designed to be a trigger for the participants to detect a cue signal for kicking (an external stimulus) and was synchronized with the motion data by the help of analog-to-digital board (NI USB 6525, National Instruments, USA). The height of the target was adjusted according to the abdominal level of the participant. It was determined by the height of the participant's navel in the fighting stance.

3. Procedures

After warming up, the participant stood barefoot on the floor with the kicking foot behind the supporting foot. Then the participant got into a fight stance with a comfortable distance between their feet and with slightly bent knees. The participants were asked to perform their comfortable rhythmic hop as a preparatory motion or not to perform rhythmic