COMPARISON OF ELECTROMYOGRAPHY ACTIVITY BETWEEN DIFFERENT TYPES OF TAEKWONDO ROUND-HOUSE KICK

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The purpose of this study was to determine the muscular characteristics involved in Taekwondo kicking by examining the difference in electromyography (EMG) activity between different types of round-house kick. Fourteen Chinese Taekwondo athletes were asked to perform four different types of round-house kick. The movement time of each type of roundhouse kick and the EMG activity of the lower extremity during kicking were collected. The two-way ANOVA with repeated measure was employed to examine the difference of movement time and EMG activity between different types of roundhouse kick. The results showed that there were significant differences in movement time between the different types of roundhouse kick ($p<.001$).

KEY WORDS: Taekwondo, round-house kick, EMG

INTRODUCTION: Taekwondo was originally developed as a fighting art in Korea and subsequently has been distributed all over the world. The competition of Taekwondo is a free-fighting combat sport, using bare hands and feet to repel an opponent. Therefore, the bare hands and kicking technique become significant factors, which have the potential to affect the Taekwondo athlete's performance. Although hands and feet can be used in Taekwondo competition game to repel an opponent, athletes prefer to use the kicking techniques rather than hand. Most of the research in this area has focussed on analysis of the kicking performance in the study of Taekwondo. Hwang (1987), Dunn (1987) and Sorensen (1996) used high-speed video filming technique for their analysis of the Taekwondo kicking technique. Moreover, Pieter (1995) used a heavy, water-filled bag with built-in pressure sensor to measure both the kicking force and kicking speed of the 1988 United States Olympic Taekwondo teams. Several studies assessed the isokinetic strength of the lower extremity in Taekwondo athletes (Pieter, 1989; Pieter, 1989; Pieter, 1990; Pieter, 1991). Not only was there bio-mechanical research that focused on the kicking technique analysis, there were also some physiological studies that concentrated on the lower extremity characteristics of the Taekwondo athlete. Lee (1996) examined the changes in muscle morphology and isokinetic strength, in Taekwondo athletes after one-legged immobilization for fourteen days.

In this study, the muscle activity during Taekwondo kicking was investigated. Moreover, the movement time of each kick was recorded in order to assess the kicking performance. EMG was employed to monitor the muscle activity during kicking. The purpose of this study was to figure out the muscular characteristics in Taekwondo kicking by examining the difference in electromyography (EMG) activity between different types of round-house kick.

METHOD: Fourteen Chinese male Taekwondo athletes participated in this study. Age, body weight and stature of the participants were 24.36 ± 8.00 years, 60.82 ± 7.02 kg and 170.71 ± 6.02 cm respectively. The training history was 7.11 ± 2.51 years, and in addition, the training frequency was 2.57 ± 1.74 hours/week. All the subjects were asked to perform four different types of roundhouse kicking at maximal effort. Each type of roundhouse kick was performed for three trials. The four types of roundhouse kicking were roundhouse kick with front leg and back leg as well as kicking to the waist level and eye level of the subject.

A light-emitting diode (LED) was placed at the top of the training bag ($\approx$ 30kg) that was also placed in front of the subject. Subsequently,an accelerometer (34100A, 15g, Summit Instruments, USA) was inserted into the training bag. The accelerometer was employed to measure the instant of the kicking. When the LED was turned on, the subject commenced kicking. A synchronized sign of a 3V DC was sent simultaneously to an IBM compatible computer with an A/D converted card (PCI-6071E, National Instruments, USA). When the subject kicked the training bag, the signal from the accelerometer was transferred to the computer for recording. The movement time was defined as the duration between receiving the

3V DC signal and the signal from the accelerometer. The EMG activity of the kicking was collected and calculated within the specified period of movement.
The EMG activity of the selected muscles was recorded with surface electrodes (T-00-S, Medicotest, Ølstykke, Denmark) attached to the skin in a standardized manner in the direction of the muscle fibers, with an inter-electrode distance of 3.5 cm. Prior to attaching the electrodes, the skin was shaved, and prepped with alcohol. EMG electrodes were attached to several sites on the dominant leg. The muscle groups included sartorius (Ch. 1), rectus femoris (Ch. 2), vastus medialis (Ch. 3), tensor fasciae latae (Ch. 4), vastus lateralis (Ch. 5), semitendinosus (Ch. 6), biceps femoris (Ch. 7) and gastrocnemius (Ch. 8). In order to normalize the muscular activity from the EMG signal, the maximum voluntary contraction (MVC) test was conducted before the kicking test.
The raw EMG signals were low-pass (600 Hz) and high-pass (10 Hz) filtered and simultaneously A/D-converted (PCI-6071E, National Instruments, USA) at a sample rate of 2000 Hz for each channel. The rectification of EMG signal and integration of EMG (IEMG) signal were calculated by an analysis software (LabView, USA) with simultaneous visual control of the signals on the computer display. Figure 1 showed the experimental design of this study.

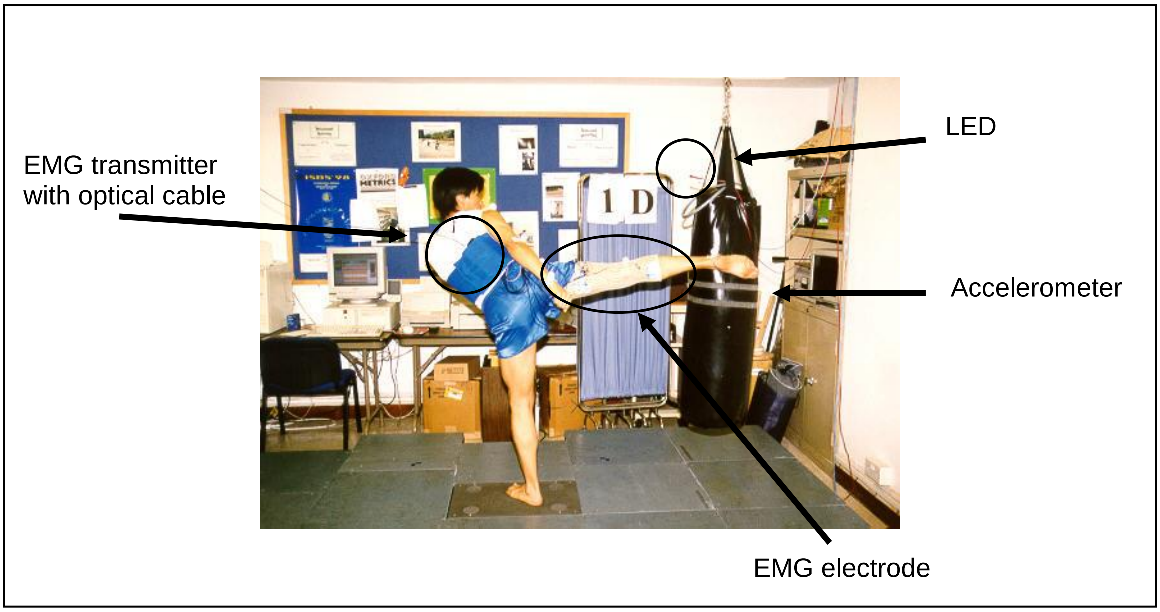

Figure 1 - The laboratory setting of the Taekwondo roundhouse kick EMG analysis.

The two-way ANOVA with repeated measure was employed to examine the difference of movement time and EMG activities between different types of roundhouse kick. Independent variables were the kicking legs and kicking levels, and the dependent variables were movement time and EMG activity at selected muscles.

RESULTS: The descriptive statistics of the movement time were shown in Table 1. The result of two-way ANOVA with repeated measure of the movement time showed that there was significant difference between different kicking levels as well as between different kicking legs used in roundhouse kick ($p<.001$).

Table 1 Descriptive Statistics of the Movement Time

	Roundhouse kick style (n=14)			
Kicking height level	Waist		Eye	
Kicking leg	Back	Front	Back	Front
Movement time (sec), (mean ± SD)	0.80 ± .00	0.71 ± .10	0.90 ± .00	0.84 ± .11

The muscle activity of the sartorius was significantly different between different kicking levels ($p<.05$) but there was no significant difference between different kicking legs used. In addition, there were no significant differences in rectus femoris and vastus medialis activities between different kicking levels and the specific kicking leg that was used ($p>.05$). The results showed that there were significant differences in tensor fasciae latae and vastus lateralis activities between different kicking levels ($p<.05$) but there was no significant difference between different kicking legs used. However, the muscle activity of semitendinosus and biceps femoris showed that there were significant differences between different legs used in roundhouse kick ($p<.05$) but that there was no significant difference between different kicking levels. Results showed that the muscle activity of gastrocnemius was significantly different between different kicking levels ($p<.05$) as well as between different legs used in kicking ($p<.001$). Figure 2 shows the graphical presentation of the eight selected muscle activities between different kicking levels and kicking legs used in performing the round-house kick.

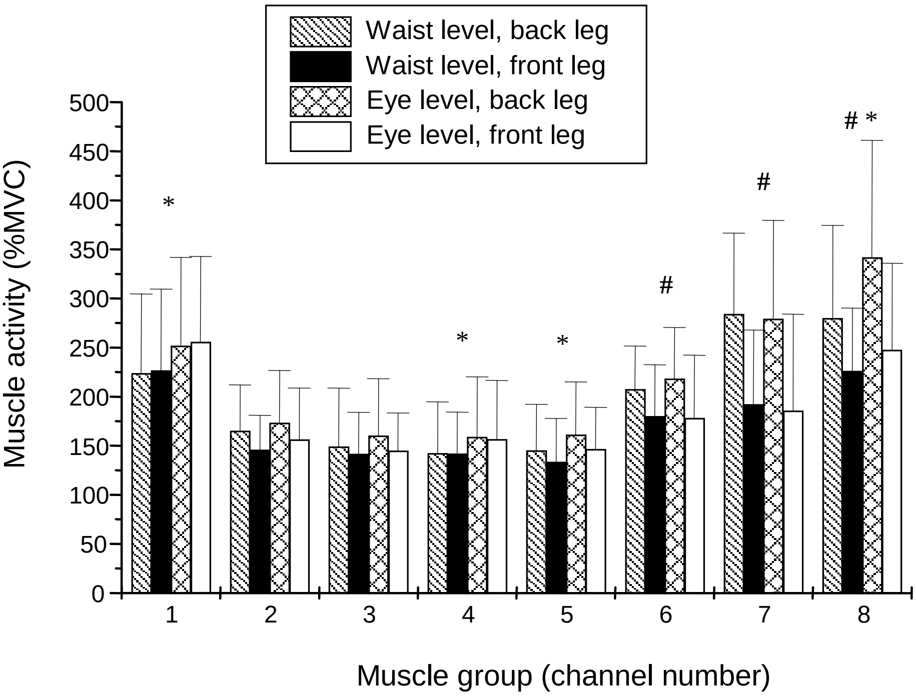

Figure 2 - EMG activity (mean ± SD) at each selected muscle during roundhouse kick between different levels and different legs used in kicking. The muscle groups included sartorius (Ch. 1), rectus femoris (Ch. 2), vastus medialis (Ch. 3), tensor fasciae latae (Ch. 4), vastus lateralis (Ch. 5), semitendinosus (Ch. 6), biceps femoris (Ch. 7) and gastrocnemius (Ch. 8).

***Significant difference between different kicking levels ($p<.05$),**
 # Significant different between different kick leg used in kicking ($p<.05$).

DISCUSSION: In the literature review on the biomechanical study of kicking, force and speed of kicking were significant parameters in assessing the kicking performance. The high speed and greater force kicking did reflect better performance in kicking at several sports such as football, Thai boxing, Karate and Taekwondo. Comparison between different types of

Taekwondo kicks such as sidekick, roundhouse kick or spinning back kick, has determined that the roundhouse kick was the fastest kicking technique (Pieter, 1995). Due to the different combination of basic skills found in Taekwondo kicking, there are many ways to perform the roundhouse kick. Sung (1987) found that technique in which the roundhouse kick was delivered to the mid-section was the fastest. The results of this study showed that the front leg in roundhouse kick was significantly faster than using the back leg. However, of the various techniques that were demonstrated, it was determined that the front leg kicking to the waist level was the fastest kicking (0.71 $\pm$ .10s) in this study.

The EMG activity of sartorius was significantly higher in kicking to the eye level than to the waist level. It may be explained by the greater hip flexion that was required in kicking to eye level. There was no significant difference between different types of roundhouse kick in the EMG activity of rectus femoris and vastus medialis. This result indicated that the muscle activity in knee extension did not show a significant difference. Muscle activity of tensor fasciae latae and vastus lateralis were significantly higher in kicking to eye level than to waist level. It is possible that there is a greater degree of hip adduction in kicking to the eye level and more rapid hip adduction in kicking to eye level than waist level. There were significant differences in the EMG activity of semitendinosus and biceps femoris between different legs used in kicking. The role of hamstrings in roundhouse kick is alternatively contacting concentrically (when the leg is flexed) and eccentrically (during leg extension at the knee joint) (Pieter, 1989). The difference in hamstring activity between different legs used in kicking may be explained by greater knee flexion in using back leg (concentric) and larger force produced in knee extension when using back leg (eccentric). The muscle activity of gastrocnemius was significantly different between different kicking level ($p<.05$) as well as with different legs used in kicking ($p<.001$). The EMG activity of gastrocnemius was seen to be significantly higher in back leg kick and eye level kick. This result indicated that the loading of gastrocnemius was significantly different between different types used for roundhouse kick. It may also imply that the contraction speed of that muscle was different when different types of roundhouse kick performed.

CONCLUSION: The front leg roundhouse kick to the waist level appeared to be significantly faster than other types of roundhouse kick ($p<.001$). The relatively higher EMG activity at sartorius, tensor fasciae latae and vastus lateralis during kicking to the eye level was demonstrated in this study. Moreover, the EMG activity of hamstrings was significantly higher in back leg roundhouse kick. The higher level of EMG activity may be explained by greater muscle loading or rapid contraction during kicking.

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