

THE KINEAMTIC ANALYSIS OF THREE TAEKWONDO KICKING MOVEMENTS

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The purpose of this study was to compare and describe the kinematic characteristics of the lower limb joints of three kicking movements in Taekwondo. Five elite female athletes served as subjects in this study. Two Peak high-speed cameras (120Hz) were synchronized to record three kicking movements. The maximum foot velocity duration of movement and the minimum knee angle in these three kicking movements have significant differences. Back round-kick and Back-kick are not whip-like movements. As for the curve of foot velocity, there is twin peak in Back round-kick. It is also notably different from the other kicking movements.

KEY WORDS: round-kick, back round-kick, back-kick, movement time

INTRODUCTION: The purpose of this study was to compare and describe the kinematic characteristics of the lower limb joints three kicking movements in Taekwondo. This sport will become an official event in 2000 Sydney Olympic Game. It is also considered a technical attack movement, engaging both hands and legs, however, in reality, it is composed of 90% kicking technology and the remaining 10% of punching attack movements (Hung,1997).

From previous studies (Chian,1991 ; Lee,1992 ; Tsia, Jiang, & Chen,1998), the sequence of kicking rate and scoring rate was found to be as follows; Round-kick, Back-kick, Ax-kick, Back round-kick and Front-kick . From Back-kicks studied (Bae,1988) it was found that the maximum power of the kicking leg occurred at the moment when the legs left the floor . When the knee of the kicking leg was at the minimum angle, the positive power of thigh plus leg was at maximum, but the negative maximum power was found to be at the moment of kicking at the target. Analyzing results of the kick and tread in Chinese martial arts (Liou,Juang,& Lian,1995), found that the maximum velocity of the CG occurred before kicking the goal. During the process of kicking, it was found that the smaller of the knee angles stored more of the electric potential energy and the larger provided power to support the leg standing on the floor. This resulted in better kicking of the goal. According to the research, the sequence of both average kicking velocity and kicking power was as follows;Round-kick, Back-kick, Back round-kick and Ax-kick (Joe,1996). In the study of Round-kick (Jang,1997) ,it was discovered that inflecting knee produced faster foot velocity and greater kicking power. Therefore, in this study the focus will be on Round-kick, Back-kick, Back round-kick and analysis of their kinematics parameters in order to provide more information to Taekwondo athletes for their practice reference. Round-kick (Figure1) is

a complex movement that includes raising the back leg knee, drawing the shank back, using the knee joint as an axis, bouncing the shank at a semi-lunar arc and driving the leg back to kick the goal (Jang, 1997). The movements of Back-round-kick (Figure 2) simply follow in the reverse direction of the Round-kick movement. The only difference between these movements is that Round-kick uses the front sole and instep, and Back-round-kick uses the heel and sole of the foot. Back-kick (Figure 3) is a movement during the first turn, and includes flexing the knee, crossing the shank and by bringing the heel near to the hip, the body leans forward and kicks out the leg.



Figure 1 - Round-kick.



Figure 2 - Back round-kick.

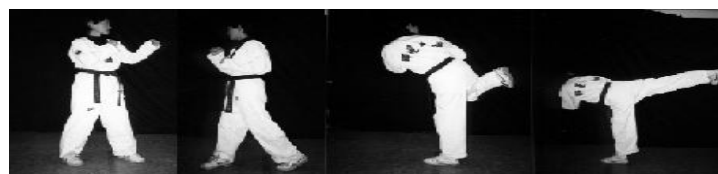


Figure 3 - Back-kick.

METHODS: Five female Taekwondo athletes from the National Taiwan Normal University Taekwondo team served as the subjects for this study. Their mean heights, weights, ages, and training years were $1.62 \pm 0.05\text{m}$, $52.4 \pm 5.8\text{kg}$, $21 \pm 1.3\text{year-old}$ and $10 \pm 0.894\text{years}$ respectively. Informed consent was obtained from each subject prior to the study. Two Peak Performance high-speed video cameras (120 Hz) were used to record kinematics parameters of Round-kick, Back-kick, Back round-kick with translation of 3-D parameters by DLT. Two cameras as shown in Figure4 were located separately by one in the side front of

the subject and the other in the side back of the subject. This study was digitized with the Peak Motus system. The segmentar center of masses and body center of mass (CM) were estimated by using the Dempster data that were provided by Winter (1990). The error of accuracy was limited to under 5/1000. The calibration errors for coordinates reference frame were obtained as listing in Table1.

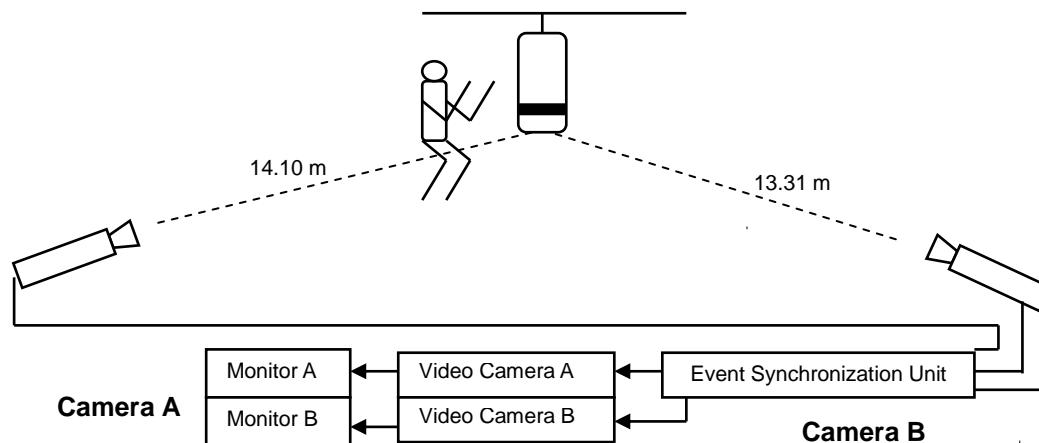


Figure 4 - The arrangement of the whole laboratory.

Table1 Calibration Errors

	X	Y	Z	Position
Mean square	0.0044	0.0038	0.0044	0.0073
Object space %	0.2015	0.2020	0.2716	0.2209

Movement time was defined as the duration from the time the foot leaves the floor to contact with the target. Because of the differences of the movement, the velocities of Round-kick and Back round-kick were determined by the movement of the toe, and the velocity of Back-kick was determined by the movement of the heel. Because of the limitation of the experiments, repeated measures were applied to process one-way ANOVA (dependent sample). The significant level was set at .95 and the results are significant. Following this, the posteriori comparison of them in Tukey's method was made.

RESULTS AND DISCUSSION:

Comparing the differences of the four variables (the maximum foot velocity, the foot velocity

at contact , movement time and the minimum knee angle) of three kicks in one-way ANOVA, the results obtained are shown in Table 2(That is, μ_1 : Round-kick, μ_2 : Back round-kick, μ_3 : Back-kick). The results are seen in Table 2

Table 2 ANOVA: Three Kinds of Kicking Movements

Variuos	Maximum foot velocity	foot velocity at contact	movement time	minimum knee angle
F	37.67*	2.66	19.85*	36.21*

From Table2, the three variables found were the maximum foot velocity, the movement time and the minimum knee angle showing significant differences in all three kicks. From the posteriori comparison in Tukey's method, the maximum foot velocity was determined $\mu_1 > \mu_2$ but $\mu_2 = \mu_3$; the movement time was $\mu_2 > \mu_1$ but $\mu_1 = \mu_3$; and the minimum knee angle was $\mu_3 < \mu_1 < \mu_2$. However, the foot velocities at the moment of hitting the target showed no significant difference among the three kicks. The sequences of the maximum velocity of

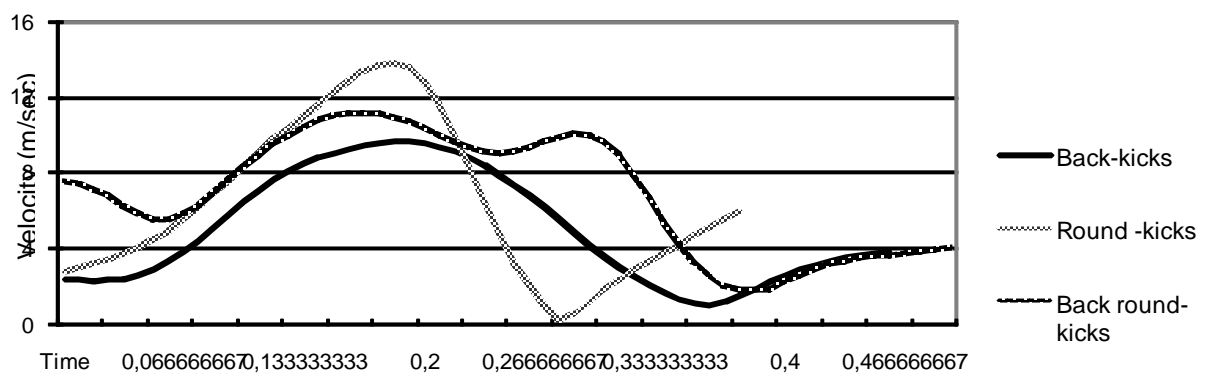


Figure 5 - The foot velocity curves.

the lower limb joints were in the order of hip, knee, ankle then toe in Round-kick (a whip-like movement), however in the Back-round kick it was shown to be the order of hip, toe and knee. In the Back-kick, the order was hip, heel then knee. These two are not whip-like movements. From the comparison of the foot velocity curves as shown in Figure5, it was discovered that Round-kick and Back-kick had single peak, but in the Back-round kick it was

twin peak. The reason for Back round-kick producing twin peaks is because that the movement has to change direction which generate two acceleration periods.

CONCLUSIONS: In the study, because the time of turning was excluded from the Back round-kick, its movement were shown to be the fastest among the three kicks, but if time for the entire movement is the concern, it would be slower than other two kicks. For this reason, athletes don't use Back round-kick very often, only occasionally applying this strategy. On the other hand, it was found that the Round-kick had faster movement than Back-kick, and it is also the reason that athletes apply it more frequently in competition. In addition, twin peak performance in Back round-kick, which was generated from two acceleration periods, was very different from other types of movement in Round-kick and Back-kick, therefore the technique can make a valuable contribution to performance in competition too.

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