

THE BIOMECHANICAL ANALYSIS OF TAEKWONDO AXE-KICK IN SENIOR HIGH SCHOOL ATHLETIC

Yeh-Jung Tsai, Shuei-Pi Lee, and Chenfu Huang
National Taiwan Normal University, Taiwan

The purpose of this study was to investigate the biomechanical factors of the Taekwondo axe-kick and compare the differences between male and female athletes for timing kinematics and kinetics. The data gained from 23 test subjects of the Taekwondo team from the junior high school (male:16, female:7). Based on the results and discussion of the study, we have reached the following conclusion: the average movement speed has significant difference between male and female groups. The average movement speed has significant positive correlation with the peak vertical ground reaction force (body weight), the peak front-rear ground reaction and impulse of the kicking leg. While the kicking leg attacked the target, the higher point of the kicking leg and the larger power of the peak front-rear ground reaction force, the faster attacking velocity (the resultant of toe velocity) at the target.

KEY WORDS: Taekwondo, axe-kick, reaction time, kinematics, kinetics.

INTRODUCTION: In Taekwondo competitions, front-kick, side-kick, back-kick, round-kick and axe-kick are the common offensive skills. Different kick actions occur with different efficiency of offense, and are suitable for different game conditions. There are two kicking action styles, medium-body attack and upper-body attack, defined by different attacking positions upon the body. Previous studies (Kim, 1988; Lee, 1992; Chein, 1991; Tsai, 1998) showed that round-kick, back-kick and axe-kick are the main offense action for offense percentage, scoring percentage and success percentage during competition. Furthermore, not only the key scoring action in the game, round-kick and back-kick also are the major training drill designed during pre-game period. The reasons for ignorance of axe-kick could be considered as long-distance and high-technique. Therefore, the athletes prefer to take the actions, which were easily to score and take more advantages of winning the game. For having the batter game, the Taekwondo official changed the rule of scoring- medium-body attack score 1 point and upper-body attack score 2 points. Based on the execution of rule, the training programs and game strategy will be focus on the skills how to improve the attack scoring of upper-body. Thus, the purpose of this study was to investigate the biomechanics of Taekwondo of axe-kick effect and compare the difference between male and female athletic on every phase time, kinematic and kinetic variable which are the main characteristics relative to Taekwondo skill.



METHODS: The data gained from 23 test subjects of the Taekwondo team from the senior high school (male:16, female:7), and their mean age, height, weight and training experience were 171 ± 1 years, 168.8 ± 5.8 cm, 59.9 ± 6.7 kg and 5.8 ± 1.6 years respectively. The experimental data were collected using Light reactor, Triple-axes accelerometer, Biopac multifunction record system. And the data could be categorized by reaction time, kinematics and dynamometry during the axe-kick action. The feet of subjects stand on two force plates separately at standby instant to gain the ground reaction force of two feet during action. And Peak Performance motion analysis system (60 Hz) also simultaneously used to record the axe-kick action, and Kistler force plate system (600 Hz) during the axe-kick movement. SPSS (for Win 98) software was used for statistical analysis, independent T-test to used in data processed to analyze the difference between male and female group and the Pearson's product-moment correlation was to test the correlation between each variable.

RESULTS AND DISCUSSION: For open-style competition, the faster athletes can react, the more time they could execute the strategy. Thus, the rapid reaction is the necessary factor for Taekwondo athlete (Chang, 1997). From the previous investigation (Chou, 1996) about analysis of four different kick actions, the results revealed that axe-kick and round kick are kicking styles with faster reaction than else. The table 1 shows that averaged reaction times are 0.524 0.052 and 0.493 0.050 s for male and female, respectively, but without significant difference between them. Male and female Generally, the athlete with faster reaction time have better control of attack distance and timing.

Table 1 Reaction times, movement times and movement velocities.

variables	Male (n=16)		Female (n=7)		t-value
	mean	SD	mean	SD	
reaction time (s)	0.523	0.052	0.493	0.050	1.31
movement time (s)	0.367	0.018	0.392	0.029	-2.16
movement velocity (m/s)	5.30	0.35	4.85	0.28	3.26*

*p<0.05

The average movement speed has significant difference between male and female groups. The average movement speed has significant positive correlation with the peak vertical ground reaction force (body weight), the peak front-rear ground reaction and impulse of the kicking leg.

Table 2 Correlation of movement velocity and biomechanical variables of the kicking leg.

variable	peak vertical ground reaction (body weight)	peak front-rear ground reaction (body weight)	front-rear impulse
Movement velocity	r=0.46*	r=0.56*	r=0.48*

*p<0.05

While the kicking leg attacked the target, the higher point of the kicking leg and the larger power of the peak front-rear ground reaction force, the faster attacking velocity (the resultant of toe velocity) at the target.

Table 3 Correlation of attacking speed and biomechanical variables of kicking leg.

variable	highest attack position	front-rear propulsive ratio
Attacking speed	0.43*	0.46*

*p<0.05

Movement time is one of the important factors of whether the kicking can score on opponent; it relative to how fast the athlete can kick efficiently. In present study, the movement time have no significant difference between male and female athletes. But the results from table 1 indicated that variable movement-velocity have significant difference (male: 5.30 0.35 m/s; female: 4.85 0.28 m/s) between them. It means that the male athletes perform larger range of kick movement.

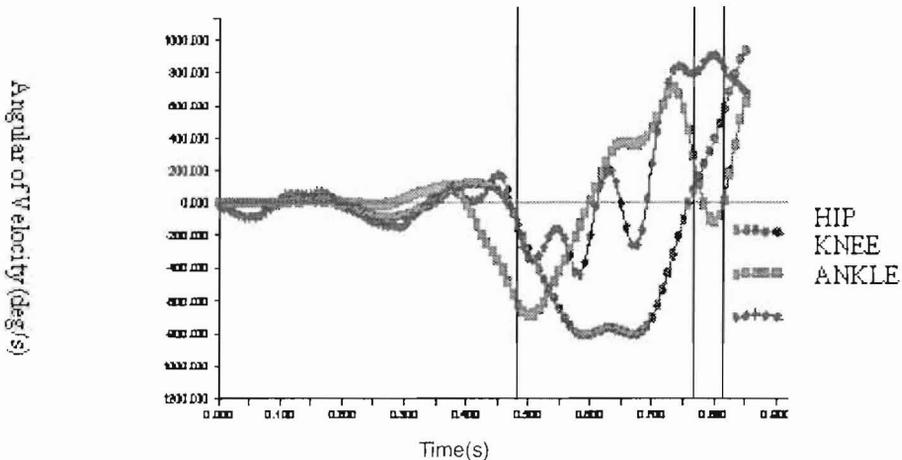


Figure 2: Angular velocities of hip, knee and ankle joints from a selected subject.

Figure 2 shows the angular velocities of hip, knee and ankle joints of the kicking action. From the characteristics, the whole movement could be separated by leg-lifted phase and leg-downward phase. By the axe-kick movement style, the figure 2 indicated that hip and knee joints sequenced by kinetic chain principle during leg-lifted phase, but without sequential accelerating during leg-downward phase. In the leg-lifted phase, part of subjects moved against the principle of kinetic chain of big joint to small joint, however, the subjects obey the principle of kinetic chain have gained the mechanics efficiency---the shorter rate (leg-lifted phase time / movement time) in leg-lifted phase time. There were kinematics characteristics as following: the lesser angular displacement of knee, the larger angular displacement of hip and the faster angular velocity of knee.

Table 4 Selected variables of kinetic chain and without sequence.

variables	Kinetic chain		without sequence		t-value
	mean	SD	mean	SD	
Minimum angle of knee	74.3	9.6	94.2	14.2	-3.94*
Maximum angular displacement of hip	154.3	8.9	163.6	8.9	-2.22*
Maximum angular displacement of knee	97.4	12.9	80.6	17.6	-2.62*
Maximum angular velocity of knee	924.8	111.6	589.9	136.2	6.47*

*p<0.05

CONCLUSION: 1. The average movement speed has significant difference between male and female groups. The average movement speed has significant positive correlation with the peak vertical ground reaction force (body weight), the peak front-rear ground reaction and impulse of the kicking leg.

2. While the kicking leg attacked the target, the higher point of the kicking leg and the larger power of the peak front-rear ground reaction force, the faster attacking velocity (the resultant of toe velocity) at the target.

3. In the leg-lifted phase, part of subjects moved against the principle of kinetic chain of big joint to small joint, however, the subjects obey the principle of kinetic chain have gained the mechanics efficiency---the shorter rate (leg-lifted phase time / movement time) in leg-lifted phase time. There were kinematics characteristics as following: the lesser angular displacement of knee, the larger angular displacement of hip and the faster angular velocity of knee.

REFERENCE:

- Chein,G.M. (1991).1991 Word Cup Taekwondo Game. Sports, 74,72-79.
- Hong,C.C. (1997).The kinetic analysis of the taekwondo back kick. Unpublished master thesis,Taipei:Chinese Culture University.
- Kim, Y. I. (1988). A Study on Frequency of Kick Technique and Points in Taekwondo Games-Focused on Women Players. University Advisor, Professor Kang Ying Ho.
- Komi, P. V. (1992). Stretch-Shortening Cycle. In P. V. Komi (Eds.). Strength and Power in Sport (pp169-179). Oxford Blackwell Scientific Publications.
- Lee, J. B.(1992). An Analytical Study on the Scoring Ability Between the Attack First and the Counter Attack in Taekwondo Game. Major in Physical Education Graduate School of Education Dong Guk University.
- Lo,Y.I.(2001).The Influence of Flexibility on the Upper Kick Movements for Women Taekwondo Contestants. Unpublished master thesis, National Sports and Education College.
- Tsai,M.H. (1998). An analysis of the attacking rate ,scoring rate and success rate of different attacking styles of the World Women's Taekwondo Championship Medallists. Unpublished master thesis. Chinese Culture University, Taipei.