THE EFFECT OF DIFFERENT PLYOMETRIC-SQUAT TRAINING ON TAEKWONDO POWER DEVELOPMENT IN THE LOWER EXTREMITY

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The purpose of this study was to investigate the effect on three different training methods by combining the typical plyometric training method (drop jump) and traditional weight training (1/2squat). The subjects were fifteen male high school athletes. The training duration for all subjects was eight weeks, and the frequency was twice a week. One Kistler force plate was used to record the power abilities of the subjects performing counter-movement jump (CMJ) and one PEAK camera (120 Hz) was also used to record the Axe-kicking movement time. Based on the results of this study, combining the vertical drop jump and horizontal drop jump with weight training could improve the maximum power and Axe-kick movement time. Therefore, it is important to consider the movement specific character when the muscular strength training of Taekwondo athletes.

KEY WORDS: taekwondo, plyometric, drop jump, power, biomechanics.

INTRODUCTION: Strength, or the ability to express force, is a basic physical characteristic that determines performance efficiency in sports. Each sport varies in its strength requirements, in the interest of specific, we should examine its relationship to speed and force (Dick, 1997). So muscular strength is the basic ability for athletes to control the more skills. Furthermore, how to improve the muscular strength is the problem which athletes and coaches often concerned about. Generally, there are three main classifications of strength, namely maximum strength, explosive strength (power) and enduring strength respectively. The kicking was the main offensive weapon for Taekwondo. The previous researches indicated that the range of movement time of Taekwondo kick were 0.22−0.31 seconds (Cho, 1996) and the maximum velocity of kick reached 22.4 m/sec (Sung, 1987). These characteristics showed Taekwondo was a so called "explosive" sport, and developed well training programs for explosive strength of lower extremity was key point to improve the Taekwondo performance. Plyometric, which developed by Veroshanski at 1991, was a effective method of training power ability. Some researches showed that combining plyometric with weight training could have more effectiveness, but there were few informations about how to apply on Takwondo sport. The purpose of this study was to investigate the effect on three different training methods by combining the typical plyometric training method (drop jump) and traditional weight training.

METHOD: The subjects were fifteen male high school athletes with the ability of 1/2 squat of one and half of their own body weight, and without any low extremity injuries. Their mean (and diviation) age, height, weight and training experience were 17.0(0.9) years, 168.7(5.5) cm, 59.5(6.9) Kg and 5.6(1.7) years, respectively. The fifteen subjects were divided randomly into three training groups: (a) 1/2 squat weight training (WT); (b) combined drop vertical jump and 1/2 squat weight training (DWT1); (c) combined drop horizontal jump and1/2 squat weight training (DWT2). The training duration for all subjects was eight weeks, and the frequency was twice a week. Table1 and table2 showed the detail training programs.
Before and after the training programs, one Kistler (model 9287) force plate was used to record the power abilities (power, force and velocity) of the subjects performing counter-movement jump (CMJ) and one high speed camera (PEAK 120Hz) was also used to record the Axe-kicking movement time (MT: time from the attack leg leave the ground to the target). Each subject had to perform three CMJs on the force plate and three Axe-kicks. The trial with maximum jumping height (HT) and maximal MT were selected to analyze the important parameters. The kinetic data (including P_{max}, F_{max} and V_{max}) and the Axe-kick movement time were collected by the Kistler and PEAK Performance software respectively.

Table 1 The program of weight training

weeks	Intensity	repetition	sets	recovery
1-2	80%	5	3	2 min
3-4	85%	4	3	2 min
5-6	90%	3	3	2 min
7-8	95%	2	3	2 min

Table2 The program of drop jump

weeks	intensity	repetition	sets	recovery
1-2	50 cm	10	3	3 min
3-4	57 cm	10	3	3 min
5-6	64 cm	10	3	3 min
7-8	71 cm	10	3	3 min

The P_{max}, F_{max} and, V were defined as the peak value of the power, force and velocity curves provided by the Kistler software (figure 1). A paired t-test was adopted to analyze the statistical differences before and after training, and Independent one-way-ANOVA was used to find out the differences among three groups.

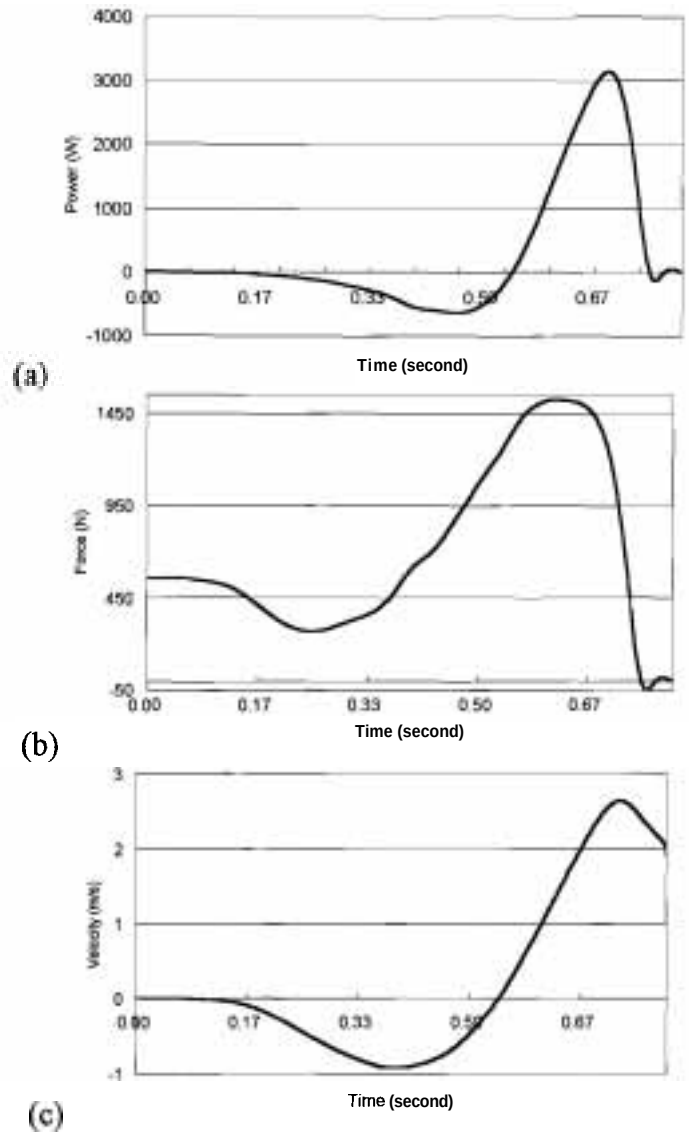

Figure 1 - The vertical components of kinematics and kinetics associated with a CMJ that (a) is power-time curve, (b) is force-time curve and (c) is velocity-time curve.

RESULTS AND DISCUSSION: Table 3 to 6 show the pre-training and post-training results. The significant improvements of the P_{max} between the training sessions for the DWT1 and D W 2 groups. For post training, there were no significant differences on the, P among the three groups. Kritpet (1989) indicated that the plyometrics training should combine with the

weight training to get the better effect. Bauer, Thayer & Baras (1990); Adams et al (1992) also support this conclusion. The results of this study indicated that combining two training methods improved the $P_{max.}$ between training sessions. For the F_{max}, there was a significant difference between training sessions for the DWT1 and WT groups. It was surprising to note that the, F had no differences for the DWT1 group. There was a significant difference between the DWT1 and WT groups for the jumping height of post-training. The DWT1 improved 4.26 cm between the training sessions. For post training, there was significant difference between the DWT1 and WT groups for the $V_{max.}$ The DWT1 improved 0.09 mlsec between the training sessions. Bobbert, M.F. (1990) indicated the most important factor for using drop jump training to improve the jumping ability is the control of the drop technique. He suggested that after landing, the athletes should quickly jump upward in order to increase the takeoff velocity.

Table 3 Mean and standard deviation for the DWT1

	Pre-test		Post-test		t-value
Variables	Mean	S.D	Mean	S.D	
P_{max}(W)	3318.40	704.70	3650.60	725.90	-2.84 *
F_{max}(N)	1516.63	141.75	1657.89	222.29	-1.86
V_{max}(m/s)	2.77	0.23	2.86	0.20	-3.95 *
J.H.(cm)	47.76	7.50	52.02	6.37	-2.22
M.T.(sec)	0.37	0.03	0.35	0.03	10.66 *

* p<.05

Table 4 Mean and standard deviation for the DWT2

	Pre-test		Post-test		t-value
Variables	Mean	S.D	Mean	S.D	
P_{max}(W)	3405.00	411.26	3727.40	391.20	-6.55 *
F_{max}(N)	1620.61	109.58	1881.56	160.39	-7.39 *
V_{max}(m/s)	2.76	0.19	2.76	0.14	0.00
J.H.(cm)	46.26	6.58	46.82	4.22	-3.42
M.T.(sec)	0.39	0.02	0.35	0.02	11.35 *

• p<.05

Table 5 Mean and standard deviation for the WT

	Pre-test		Post-test		t-value
Variables	Mean	S.D	Mean	S.D	
P_{max}(W)	2707.80	286.17	2993.00	391.49	-2.75
F_{max}(N)	1416.56	189.63	1675.55	301.94	-2.93 *
V_{max}(m/s)	2.46	0.30	2.55	0.10	-0.84
J.H.(cm)	40.70	4.95	41.05	2.59	-0.28
M.T.(sec)	0.42	0.04	0.38	0.02	2.64

* p<.05

For the MT, there was significant difference between the training sessions for the DWT1 and DWT2 groups. This may due to the movement pattern of the Axe-kick which emphasises kicking upward and forward. Bloodfield et al. (1990) indicated that the weight training improved the muscular strength but not throw velocity. The results of this study showed the WT groups improved the muscular strength, which have the highest improvement value (258.99 Newton) among the three groups but no significant improvement in the MT.

Table 6 Mean and standard deviation for the three groups: DWT1, DWT2 and WT

Variables	DWT_1 Mean (S.D)	DWT_2 Mean (S.D)	WT Mean (S.D)	t-value	Post-hoc
P_{max}(W)	3650.36 (725.98)	3727.40 (391.20)	2993 (391.49)	2.93	
F_{max}(N)	169.00 (22.66)	191.80 (16.35)	170.80 (31.39)	1.37	
V_{max}(m/s)	2.86 (0.20)	2.76 (0.14)	2.55 (0.10)	5.27 *	DWT_1 >WT
J.H.(cm)	52.02 (6.37)	46.82 (4.22)	41.05 (2.59)	6.95 *	DWT_1 >WT
M.T.(sec)	0.35 (0.03)	0.35 (0.02)	0.38 (0.02)	3.71	

* p<.05

CONCLUSION: This study was to combine the typical plyometric training method and traditional weight training (1/2squat) to investigate the effect on three different training methods. Based on the results and discussion of this study, we reached the following conclusion: Combining the vertical drop jump and horizontal drop jump with weight training could improve the maximum power and Axe-kick movement time. Therefore, it's important to consider the movement specific character during the muscular strength training of Taekwondo athletes.

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