Original Article

Sport-specific balance ability in Taekwondo practitioners

SHIRLEY SIU MING FONG[1] , CANDY KA YAN CHEUNG[2], JANICE YAN IP[2], JOE HO NAM CHIU[2], KAREN LOK HENG LAM[2], WILLIAM WAI NAM TSANG[2]

[1]*Department of Health and Physical Education, The Hong Kong Institute of Education, Hong Kong*
[2]*Department of Rehabilitation Sciences, The Hong Kong Polytechnic University, Hong Kong*

ABSTRACT

Fong SSM, Cheung CKY, Ip JY, Chiu JHN, Lam KLH, Tsang WWN. Sport-specific balance ability in Taekwondo practitioners. *J. Hum. Sport Exerc.* Vol. 7, No. 2, pp. 520-526, 2012. Taekwondo is a combat sport emphasizing on kicking techniques and dynamic footwork. Specialized balance ability is crucial for Taekwondo practitioners. This study aimed to compare (1) the postural stability during turning, and (2) the forward lunge distance between adolescent TKD practitioners and non-practitioners. Nineteen TKD practitioners (12 males, 7 females; Mean age ± SD: 15.58 ± 1.07 years) and nineteen control participants (13 males, 6 females; Mean age ± SD: 16.21 ± 0.98 years) were recruited in the study. Balance performance was assessed by the Forward Lunge Test and Step/Quick Turn Test with the NeuroCom Balance Master system. Forward lunge distance, turn time and turn sway were measured. TKD practitioners were found to turn faster by 35.37% (p=0.004) and sway less during turning by 15.23% (p=0.034) than non-practitioners. The forward lunge distance in TKD practitioners was 5.67% shorter than that in control participants (p=0.046). This study shows that TKD practitioners might have sport-specific balance ability. The findings of this study inspire the exploration of the longitudinal training effect of TKD so as to develop the evidence base for this exercise option to improve the postural control of adolescents with balance problems. **Key words**: MARTIAL ART, POSTURAL CONTROL, TURNING, FORWARD LUNGE

Corresponding author. Room 13, 2/F, Block D4, Department of Health and Physical Education, The Hong Kong Institute of Education, 10 Lo Ping Road, Tai Po, N.T., Hong Kong.
E-mail: smfong_2004@yahoo.com.hk
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INTRODUCTION

Taekwondo (TKD) is a combat sport renowned for its swift high kicks and dynamic footwork. Its popularity has been rising among young people since its inclusion in the Sydney Olympics in year 2000 (Pieter and Heijmans, 2000; Park et al., 1989). Postural control is crucial for TKD practitioners due to its dynamic kicking nature (Pieter and Heijmans, 2000; Leong et al., 2011). To date, only three studies have addressed the effect of TKD training on balance performance (Brudnak et al., 2002; Cromwell et al., 2007; Leong et al., 2011). Brudnak et al. (2002) revealed that 17 weeks of TKD training could improve the balance time in single leg stance in elderly. Similarly, Cromwell et al. (2007) demonstrated positive effects of TKD training on balance and mobility in older adults, as indicated by the improvement in functional reach distance, Time Up-and-Go test, walking velocity and gait stability. These two studies consistently show that older adults could benefit from TKD training in terms of various balance components. However, similar research on the young population is limited.

There was one study conducted to address the effect of TKD training in the young population (Leong et al., 2011). The results showed that, even with low-level TKD training (less than four hours per week), recreational TKD practitioners had better balance performance than their sedentary counterparts when standing with eyes closed and stabilization after dropping from height (Leong et al., 2011). However, TKD is a dynamic sport and it has many unique features, for example, turning and kicking, advancing and kicking. How do these specialized footwork and kicking skills training affect the dynamic balance in TKD practitioners? Research in this specific area is limited. Exploring these sport specific balance abilities in TKD practitioners is important as findings would have a clinical implication of implementing TKD movements for the rehabilitation of young people with balance problems.

In the routine practice of TKD, one of the most frequently used skills is roundhouse kick (Falco et al., 2009). Other commonly used techniques include side kick, back kick and spinning kick (Pieter and Heijmans, 2000). Rotation of the body and pivoting on one leg is an essential component in all of these kicking skills. Previous studies found that elite TKD athletes could turn and kick at high speeds (5.2m/s to 16.26m/s) and they generate huge amount of striking forces (390.7N to 661.9N) without loosing balance (Pieter and Pieter, 1995; Lee et al., 2008). In addition to turning and kicking, TKD practitioners adjust their body position and distance to the opponent frequently by stepping to different directions during competitions in order to score points. Attacks are typically preceded by steps to confuse the opponent, while defensive manoeuvres are preceded by steps to get out of the line of attack (Pieter and Heijmans, 2000). It is, therefore, reasonable to hypothesize that TKD practitioners might have developed specific balance ability during turning and stepping so that they would not fall and lose points during competitions.

Maintaining body stability during turning and stepping is crucial, not only for maximizing sports performance, but for many daily activities (Fong et al., 2012; NeuroCom, 2008). The findings of this study could inspire the exploration of implementing TKD as a therapeutic exercise for individuals with specific balance disorders (e.g. children with developmental coordination disorder). Therefore, this study aims to compare (1) the postural stability during turning, and (2) the forward lunge distance between adolescent TKD practitioners and non-practitioners.

MATERIAL AND METHODS

Participants

Thirty-eight participants were recruited as a sample of convenience for this study. Nineteen were recreational TKD practitioners (12 males, 7 females; Mean age ± SD: 15.6 ± 1.1 years) recruited from two local TKD associations. They had practised TKD for three to twelve years and attained red belt level or above. They were trained in TKD for two hours per week and they did not have any other physical training. The other nineteen participants (13 males, 6 females; Mean age ± SD: 16.2 ± 1.0 years) were normative adolescents recruited from the community with gender matched. All of them did not receive any regular physical training. The exclusion criteria included the presence of musculoskeletal, visual, vestibular or neurological disorders that might affect balance ability and any injury in the past six months that might affect mobility. The study was approved by the human subjects ethics review subcommittee of the administering institute. The procedures were fully explained to the subjects and they all gave their written consents before testing and all procedures of this study were performed in accordance with the Declaration of Helsinki.

Procedures and measures

Dynamic balance was assessed through two tests, including the forward lunge test (FL) and step/quick turn (SQT) test, using the NeuroCom Balance Master (NeuroCom International Inc., Clackamus, Oregon) (Naylor and Romani, 2006). Both tests were performed in barefoot condition on the long force plate system. Inter- and intra-rater reliability for the FL test (ICC r=0.71 to r=0.93) and SQT test (ICC r=0.70 to r=0.88) were found to be good to excellent (Naylor and Romani, 2006).

Forward Lunge Test

The participants were asked to stand at the end of the long force plate with their feet placed about shoulder width apart. They were instructed to lunge forward as fast and as far as possible on the dominant leg, which was defined as the one used to kick a ball (Fong & Ng, 2006), and then return to the starting position (standing). The hands were placed wherever the participant felt comfortable (NeuroCom, 2008). All participants watched a video demonstration and had one familiarization trial before the actual test. The forward lunge distance, which was defined as the length of forward movement of the centre of pressure (COP) and expressed as a percentage of the body height, was documented. Only the forward lunge distance of the dominant leg was selected for analysis because no difference was found in the forward lunge distance between two legs in healthy young people (Crill et al., 2004). The test was repeated three times with a ten-second rest in between trials. The mean value of the forward lunge distance was used for analysis.

Step/ Quick Turn Test

This test measured the postural stability of the participants during turning on the NeuroCom Balance Master force-plate. All participants followed a video demonstration and had one familiarization trial before the actual test. To start the test, the participants were instructed to stand with their feet about shoulder width apart at the end of the force plate. The participants were then required to take two steps forward, starting with either left or right leg, quickly turn 180° and step back to the starting position. Their performance was assessed separately when turning to the left and to the right, with three trials in each direction. Average measures of the turn time and turn sway were derived for turning to both sides. Turn time is defined as the number of seconds required for the individual to complete the 180° in-place turn while turn sway is defined as the average COP sway velocity (°/s) during the turn (NeuroCom, 2008). The time spent and sway velocity during turning to the non-dominant side were used for analysis only. It is because the differences between the two legs in turn time and turn sway were small (effect size = 0.09 and 0.20, respectively) (Naylor and Romani, 2006).

Statistical analysis

Descriptive statistics were used to describe all relevant variables. Normality of data was checked using the Kolmogorov-Smirnov test. Independent t-tests were used to compare the age, body height and weight between the TKD and the control group.

To compare the turn time and turn sway of the SQT test between the two groups, multivariate analysis of variance (MANOVA) incorporating all outcomes was performed. The results showed the effects of group on the primary outcomes as well as the corresponding Bonferroni-adjusted p values, thus avoiding the increased probability of type one errors associated with multiple comparisons. Partial eta-squared, which is the standardized measure of effect size within the context of MANOVA, was also presented for each primary outcome. By convention, partial eta-squared values of 0.01, 0.06, and 0.14 are considered to be small, medium, and large, respectively (Portney & Watkins, 2009).

For the FL test, independent t-test was performed to compare the FL distance in the dominant leg between the two groups. Cohen's d, which is the standardized measure of effect size within the context of t-test, was also presented. By convention, d values of 0.2, 0.5, and 0.8 are considered to be small, medium, and large, respectively (Portney & Watkins, 2009). A significant level of 0.05 was set for all statistical tests (two-tailed).

RESULTS

Independent t-test revealed no significant difference in age, height and body weight between the two groups (Table 1). MANOVA revealed an overall significant difference in functional balance performance in the SQT test between the two groups (Wilk's λ=0.772, p=0.011). When each individual primary outcome was considered, the between-group difference remained significant. The turn time (turned to non-dominant side) was 35.37% faster in the TKD practitioners than the non-practitioners (p=0.004). The degree of sway during turning (turned to non-dominant side) was also 15.23% less in the TKD practitioners than the non-practitioners (p=0.034). However, independent t-test revealed that the FL distance in the TKD practitioners was 5.76% shorter than the non-practitioners (t_{36}=-2.088, p=0.046) (Table 2). For those outcomes in the SQT test that showed significant between-group differences, the partial eta-squared values ranged from 0.119 to 0.207, indicating large effect size. Cohen's d value in the FL test was 0.677, indicating medium effect size (Table 2).

Table 1. *Subject characteristics.*

	TKD group (n=19)	Control group (n=19)	p value
Age±SD, year	15.58±1.07	16.21±0.98	0.065
Gender (Male/Female), n	12/7	13/6	
Height, cm	163.89±9.64	168.37±6.53	0.103
Weight, kg	57.66±15.76	60.16±9.94	0.563

Table 2. *Results of step/quick turn test and forward lunge test.*

	TKD group (n=19)	Control group (n=19)	P value	Effect size
Step/quick turn test				
Turn time – turned to non-dominant side (s)	0.53±0.25	0.82±0.32	0.004**	0.207
Turn sway – turned to non-dominant side (°/s)	20.54±4.70	24.23±5.58	0.034*	0.119
Forward lunge test				
Forward lunge distance with dominant leg (% of body height)	58.53±6.59	62.11±3.53	0.046*	0.677

DISCUSSION

This study demonstrates that adolescent TKD practitioners required less time to complete a 180-degree-turn and swayed less during turning than non-practitioners. Both parameters indicate better postural control during step-quick-turn test of TKD practitioners than the control group. The observed difference in functional balance performance between the two groups might be explained by the possible neuro-physiological changes as a result of TKD training. Previous studies found that H-reflex excitability was reduced in athletes who were trained in sports with high postural demand, for example, ballet dancers (Nielsen et al., 1993). A suppression of H-reflex would reduce muscle spindle activation and thus enhance postural control (Llewellyn et al., 1990). This neurological change might also happen in the TKD practitioners in light of the high balance demand during TKD training which is comparable to ballet training (e.g. spinning on one leg) (Nielsen et al., 1993).

Apart from the possible neurological changes at the spinal level, sensory adaptation for postural control could also happen at the supraspinal and peripheral levels in TKD practitioners (Perrin et al., 1998; Borysiuk & Waskiewicz, 2008; Leong et al., 2011). Leong et al. (2011) postulated that young TKD practitioners might rely more on the somatosensory and vestibular inputs to maintain balance. This is because TKD training involves repetitive weight-shifting actions and high speed turning kicks that might enhance functions of the somatosensory and vestibular systems. In addition, TKD practitioners and those in other similar combat sports turn to have superior sensory information processing ability than the non-practitioners, resulting in better trunk/ limb coordination and more accurate use of postural strategies (Perrin et al., 1998; Borysiuk & Waskiewicz, 2008).

Our results also reveal that the forward lunge distance was 5.67% shorter in the TKD practitioners than the non-practitioners. Although the TKD practitioners were found to have better single leg standing balance than the non-practitioners in one of our previous studies (Fong & Ng, 2010), they did not attempt to lunge too far forward in the present study. The explanation might be that TKD training emphasizes quick turning and weight-shifting, and lunging in shorter steps ensures faster weight-shifting and smaller displacement of the COP. This favours the execution of TKD kicks in terms of speed and stability (Pieter & Heijmans, 2000). Since the neuro-physiological adaption induced by sport training is task-specific (Perrin et al., 2002), TKD practitioners might adapt to short lunging distance during training.

This study suggests that TKD could be a suitable sport to improve the dynamic balance, particularly during turning, in adolescents. Our findings have a clinical application value of implementing TKD elements (e.g. turning and kicking) for the rehabilitation of young people with balance problems (e.g. children with developmental coordination disorder).

There are some limitations in this study that need to be considered when interpreting the findings. First, it is a cross-sectional study, the causal relationship between TKD training and balance performance cannot be established. This would best be confirmed by a longitudinal study. Second, only the functional balance performance was tested in our study. Further study is needed to explore the underlying mechanism contributing to the better balance ability in TKD practitioners.

CONCLUSIONS

Adolescent TKD practitioners demonstrated better dynamic balance during turning than the non-practitioners. However, they have shorter forward lunge distance than controls. Further study is needed to explore the longitudinal training effect of TKD so as to develop the evidence base for this exercise option to improve the postural control of adolescents with balance problems.

POTENTIAL CONFLICT OF INTEREST STATEMENT

No financial support was provided for the preparation of this paper and the authors have no conflicts of interest that are directly relevant to the content of this article.

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