

TEMPORAL ANALYSIS OF TYPICAL TAI CHI FORM - BRUSH KNEE TWIST STEP

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The purpose of the study was to compare the difference of movement time of typical Tai Chi form - Brush Knee Twist Step in Tai Chi practitioners at different stages during their years of training. Fifteen subjects were recruited and assigned to three groups according to their years of Tai Chi training. The subjects' years of training in Groups 1, 2, and 3 were 2.4 - 0.7, 5.4 - 0.6, and 18.2 - 9.7 years, respectively (N = 5 in each group). Two Kistler force platform was employed to measure the instant of touch down and take off in the selected Tai Chi form. The results indicate that the movement time of the subjects with longer training duration (Group 3) was significantly longer than those with shorter training duration in Group 1 and Group 2. On further analysis, it was found that the double leg support time in Group 3 was longer than in Group 2 and Group 1.

KEY WORDS: Tai Chi, movement time, double leg support, single leg support.

INTRODUCTION: Scientific studies have proved that Tai Chi exercise has considerable effects on the physical fitness and balancing ability of the practitioner (Hain et al., 1999; Hong et al., 2000; Lai et al., 1993; Lan et al., 1999; Lan et al., 1998; Lin et al., 2000; Schaller, 1996; Shih, 1997; Tse & Bailey, 1992; Wolf et al., 1996; Wolf et al., 1993; Wong et al., 2001). Recently, Tai Chi exercise has come to be considered a therapeutic exercise since it includes weight bearing movement from bilateral to unilateral support and a large degree of trunk and arm rotation with a diminishing base of support (Ross & Presswalla, 1998; Wolf et al., 1997). However, they were unable to find any biomechanical description of the Tai Chi movements that might enable improvements in the movement ability of Tai Chi practitioners (Wolf & Gregor, 1999). Such information may be useful for coach, surgeon, therapist, and kinesiologist in their diagnostic assessments (Winter, 1990). Therefore, the purpose of the study was to investigate the movement characteristic of Tai Chi movement by comparing the difference of movement time of typical Tai Chi form - Brush Knee Twist Step (see Figure 1) in Tai Chi practitioners at different stages during their years of training.

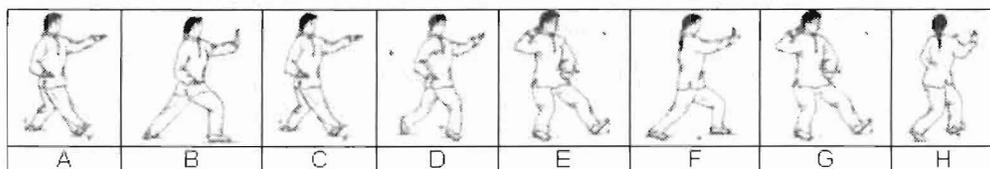


Figure 1: The typical Tai Chi form - "Brush Knee Twist Step".

METHODS: Fifteen healthy subjects were recruited for the study. Subjects were assigned to three groups according to their years of Tai Chi training. The subjects' years of training in Groups 1, 2 and 3 were 2.4 - 0.7, 5.4 - 0.6, and 18.2 - 9.7 years, respectively. There were 5 subjects in each group. All of the subjects practiced Yang's style of Tai Chi exercise and had no other sporting background or history.

The testing took place in the Human Movement Laboratory. The experimental procedures were approved by the local Medical Ethics Committee. Informed consent and explanation of study were provided to the subject before the formal test.

Subjects were asked to perform the typical Tai Chi form "Brush Knee Twist Step" after the warm up exercise.

Two force platforms (Kistler 9281CA, Switzerland) were used to record the moment of heel touch down and toe-off in the typical Tai Chi form. The data acquisition software, Labview 4.0 (National Instrument, USA), was employed in this study to collect data from the force platforms. The sampling rate of the analog/digital (A/D) card (PCI-6071E, National Instrument, USA) was

set at 1000Hz. The A/D card and the data acquisition software were installed in an IBM compatible computer (Duel Intel PIII350, 298Mram) with Windows NT platform to collect data in this study.

The variables such as the total movement time, single leg support time and the double leg support time could be obtained from the force platform data.

One-way MANOVA was employed to compare the difference of variables between subject groups. The significant level was set to 0.05 and SPSS software was used for statistical analysis.

RESULTS: The mean and standard deviation of total movement time, single leg support time and double leg support time of each subject group are shown in Table 1. The One-way MANOVA demonstrated a significant main effect for the movement time between groups (Wilks' Lambda = .165, $p < .05$). This significant result allowed for further univariate analysis to determine which dependent variables were significant. The univariate subsequence ANOVA found a significant main effect at the total movement time ($F = 11.958$, $p < .05$) and double leg support time ($F = 21.228$, $p < .05$). A post hoc multiple comparisons Scheffe test indicated that the movement time in Group 3 (20.84 ± 3.28s) was significantly longer than Group 1 (14.29 ± 2.96s) and Group 2 (12.81 ± 1.85s). In double leg support time, the post hoc test result showed that Group 3 (8.99 ± 1.84s) performed significantly longer than Group 1 (6.12 ± 1.23s) and Group 2 (5.00 ± 0.67s).

In order to investigate the feature of the double leg support period, further analysis was conducted on the movement time at different phases. The One-way ANOVA indicated the significant main effect at right touch down (A - B, see Figure 1) movement time ($F = 24.280$, $p < .01$) and left touch down (E - F, see Figure 1) movement time ($F = 21.293$, $p < .01$). The post hoc multiple comparisons Scheffe test showed that touch down movement time at both left and right were significantly longer in Group 3 than in Group 1 and Group 2 (see Table 2).

Table 1 Mean and Standard Deviation of Total Movement Time (sec), Single Leg Support Time (sec) and Double Leg Support Time (sec) at Different Groups.

Variable	Group	Mean	S.D.
Total movement time	1	14.29*\$<	2.96
	2	12.81*†	1.85
	3	20.84	3.28
Single leg support	1	1.06	0.51
	2	1.26	0.50
	3	1.27	0.40
Double leg support	1	6.12*\$<	1.23
	2	5.00*†	0.67
	3	8.99	1.84

* $p < .05$, "\$" = Group 1 vs Group 2; "..." = Group 2 vs Group 3; "<" = Group 3 vs Group 1.

DISCUSSIONS: There has been little research into the differences in the movement characteristics of Tai Chi practitioners at different stages of training. In the present study, we investigate the movement time, double leg support time and single leg support time achieved by subjects with different durations of training in the Tai Chi forward stance "Brush Knee Twist Step". The present study indicates that subjects with longer training duration (Group 3) took more time to shift their body weight from one leg to the other. Such weight-bearing exercises were not recommended because of the potential for exacerbation of degenerative changes in the joints and the greatly increased risk that the joint reactive forces might have worsened joint

symptoms (Lumsden et al., 1998). However, Kirsteins, Dietz, & Hwang (1991), investigating the safety of Tai Chi exercise (weight bearing exercise), found no significant exacerbation of joint symptoms (Kirsteins et al., 1991). Moreover, they recommended the shifting of body weight in Tai Chi exercises not only for strengthening the lower extremity muscles, but also developing the skills needed for achieving unilateral weight and balance through self-awareness of limitations in postural stability (Wolf et al., 1997). Actually, the phases of the gait cycle involving shifts in weight support are critical periods for balance control (Wolf & Gregor, 1999). Therefore, Tai Chi practitioners with long training duration spent more time in the shifting of body weight phases, which may reinforce the training effect of the balance control of the body.

Table 2 Mean and Standard Deviation of Movement Time (sec) at Right and Left Touch Down Within the Stance Period of the Tai Chi Movement.

Variable	Group	Mean	S.D.
Movement A - B	1	2.43**§<	0.58
	2	2.16**†	0.63
	3	4.48	0.48
Movement E - F	1	2.40**§<	0.56
	2	2.10**†	0.63
	3	4.32	0.55

**p < .01, "§" = Group 1 vs Group 2; "..." = Group 2 vs Group 3; "<" = Group 3 vs Group 1.

CONCLUSION: In the typical Tai Chi form - Brush Knee Twist Step, the Tai Chi practitioners with long training duration spent more time in the double leg support phase within the stance period. Further analysis showed that they spent significant long time in shifting of body weight from one leg to another which may reinforce the training effect of the Tai Chi exercise on the balance control of the human body.

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