ISB 2013 BRAZIL
XXIV CONGRESS OF THE INTERNATIONAL SOCIETY OF BIOMECHANICS
XV BRAZILIAN CONGRESS OF BIOMECHANICS

EFFECTS OF TAI CHI CHUAN EXERCISE ON CROSSING OBSTACLE IN ELDER

Yao-Ting Chang, Jung-Chun Chi, *Jia-Hao Chang and Chen-Fu Huang
Department of Physical Education, National Taiwan Normal University, Taipei, Taiwan
*email: jhchang@ntnu.edu.tw

SUMMARY
The purpose of the study was to evaluate effects of Tai Chi Chuan exercises on strategies of crossing obstacle in older adults. Tai Chi elder were compared with normal elder for performances of ground reaction force in crossing obstacles. The results showed that Tai Chi elder could propel their center of mass forward more while leading foot crossing obstacles. And for higher obstacles, exactly controlling the swing foot was more important while swing foot crossing obstacles.

INTRODUCTION
Aging results in degenerations of capacities of physical activity. Elderly may perform worse in daily tasks such as crossing obstacles due to aging. It may also increase fall risks for elder [1]. Tai Chi Chuan exercise could decrease aging and enhances the capacity of physical activity and reduce the risk of accidents for older adults [2]. The purpose of this study was to evaluate effects of Tai Chi Chuan exercises on strategies of crossing obstacle in older adults.

METHODS
Fifteen healthy elder (71.73±4.72 years, 160.13±7.16 cm, 58.30±6.67 kg) who regularly practiced Tai Chi exercise three days a week and more than five years participated in this study as a Tai Chi group (TCG). Fifteen normal healthy elder (72.6±5.61 years, 163.13±8.49 cm, 59.97±8.62 kg) participated in this study as a control group (CG).

Each participant walked at 8 m walkway in the laboratory and crossed a height-adjustable obstacle that was composed of a thin, light and soft rod placed across a metal frame (Figure 1). The rod would drop while contacting by participants for preventing falls. Three-dimensional marker trajectories were measured using Vicon motion capture system at 250 Hz. Two Kistler force plates were placed on either side of the obstacle to measure the ground reaction forces (GRF) at 1000 Hz. Test conditions included crossing obstacles of three different heights (10%, 20% and 30% of leg length). For all conditions, participants were instructed to walk along the walkway barefoot in normal speed and step over the obstacle. Three successful trials for each condition were obtained. Anterior-posterior and vertical ground reaction force of the support leg when the swing toe marker was vertically above obstacle was calculated. The data was normalized to the body weight.

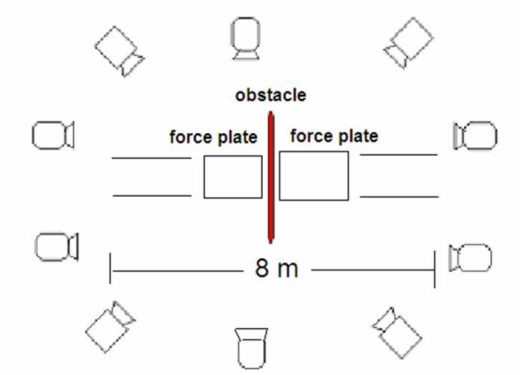

Figure 1: Top view of the laboratory setting

Mixed design two-way ANOVA were used to test the difference in variables among two groups (TCG and CG) and three obstacle heights (10%, 20%, and 30% leg length). The effect of obstacle height was examined by Scheffe's method post hoc comparisons. All significance levels were set at $\alpha = .05$. SPSS 20 (SPSS Inc., Chicago, USA) was used for statistical analyses.

RESULTS AND DISCUSSION
Table 1 showed the ground reaction forces on support leg when the toe marker of the crossing foot was vertically above obstacle. While the toe marker of the leading foot above on the obstacle, the Tai Chi group revealed forward ground reaction force on support foot. Contrary to Tai Chi group, the control group revealed backward ground reaction force on support foot at the same moment. The Tai Chi group also revealed the smaller vertical ground reaction force on support foot while the toe marker of the leading foot above on the obstacle. Moreover, the vertical ground reaction force on the trailing foot and the anterior-posterior ground reaction force on the leading foot showed high effect (10%>20% LL, 10%>30% LL). And the anterior-posterior ground reaction force on the trailing foot was significantly different between two obstacle heights (10% and 30% LL).

The forward ground reaction force in Tai Chi group indicated that Tai Chi elder were at latter stance phase while they lifted leading toes above on the obstacle. Tai Chi elder could propel their body forward and cross the obstacle at the same time. Backward ground reaction force in normal group implied that even the leading leg swing to the front of the

support leg, COM of normal elders were still at the back of the support leg. Normal elder needed to do more efforts in body control and balance to lift swing legs as they cross the obstacle. Both groups of elders needed to do more efforts in body control and balance as they lifted leading swing leg higher to cross higher obstacle. In the current study, vertical and forward ground reaction forces were not the maximum and decreased as the height of obstacle increased when the leading swing foot was vertically above on the obstacle. It revealed that exactly controlling the swing foot was more important than raising body up at this moment.

CONCLUSIONS

Tai Chi elder and normal elder showed different strategies while leading foot crossing obstacles. Tai Chi elder could propel their center of mass forward more. Normal elder needed to do more effort in controlling balance. It was considered that Tai Chi Chuan exercise improved the capacity of physical activity for elderly. And it resulted in the better performance in crossing obstacles.

ACKNOWLEDGEMENTS

This study was supported by "Aim for the Top University Plan" of the National Taiwan Normal University and the Ministry of Education and National Science Council (NSC 97-2410-H-003-095-MY2), Taiwan, R.O.C.

REFERENCES

1. Blake AJU, et al., *Age and Ageing*. **17**:365-372, 1988.
2. Qin L. et al., *Journal of Bone and Mineral Metabolism*, **23**:186-190, 2005.

Table 1: Means (SD) of anterior-posterior GRF and vertical GRF of support foot for both groups when the toe markers of the leading foot or trailing foot was vertically above obstacle with three different heights. The unit was body weight (BW).

Obstacle height (LL)	10%		20%		30%		*High effects*
	TCG	CG	TCG	CG	TCG	CG	
Trailing foot support							
$GRF_{A\,(+)\,/\,P\,(-)}$*	0.02 (0.01)	- 0.02 (0.01)	0.01 (0.01)	- 0.02 (0.02)	0.01 (0.01)	- 0.02 (0.02)	*10% ≠ 30%*
$GRF_{vertical}$*	0.73 (0.08)	0.84 (0.05)	0.72 (0.06)	0.81 (0.05)	0.71 (0.10)	0.80 (0.05)	*10%>20%, 10%>30%*
Leading foot support							
$GRF_{A\,(+)\,/\,P\,(-)}$	0.04 (0.03)	0.03 (0.02)	0.03 (0.03)	0.02 (0.02)	0.03 (0.03)	0.02 (0.03)	*10%>20%, 10%>30%*
$GRF_{vertical}$	0.84 (0.07)	0.85 (0.07)	0.82 (0.06)	0.84 (0.11)	0.86 (0.10)	0.84 (0.15)	*No*

* Significant differences between two groups ($p < 0.05$)