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STEPPING CHARACTERISTICS BEFORE STAIR WALKING TRANSITONS IN TAICHI ELDERLY

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The purpose of this study was to investigate the difference between TC exerciser and normal elderly in stepping characteristics before stair walking transition. There were 12 TC practitioner elderly and 14 matched controls participated in this stady. Ten Vicon high-speed cameras (250Hz) were utilised to collect kinematic data. Results showed that TC group presented faster CoM velocity during descending and following walk. At the moment of just before transition, TC group showed faster resultant / horizontal CoM velocity, TOE resultant / vertical velocity. TC group also demonstrated greater stride length while contacting the ground. We concluded TC group had better abilities of body control. Faster horizontal CoM velocity and vertical TOE velocity negotiated before transiton in TC group, would be order to transit the unstable situation more efficient.

KEY WORDS: negotiation, centre of mass, foot.

INTRODUCTION: Stair walking was in turns consisted of forward walking and downward descending. The transition strides were constituted two discrete walking patterns, and as such were inherently variable and unstable. Increased falls were occurred during the transition strides before and after stair walking (Sheehan & Gottschall, 2011). Injuries related to falls included muscle strains, fractures and even more serious complications.

Older adults had been reported high incidence of falling while descending because of age-related declines in body control abilities. The safety precautions were utilised in older adults, such as lower speed, closer positioning and use of the handrails. (Hamel & Cavanagh, 2004; Lee & Chou, 2007; Mian, Narici, Minetti, & Baltzopoulos, 2007). Center of mass is calculated by whole body kinematics and segmental parameters, delegating the individuals movement. Mian, Narici, Minetti, and Baltzopoulos (2007) indicated healthy older do not exhibit an altered strategy in traversing the CoM in the plane of progression during stair negotiation by assessing the interaction of CoM and center of pressure (CoP). Limitation in step tread duing stair walking, the interaction of CoM and CoP wouldn't be different. To further investigate the efficiency and stability during transition, assessing CoM characteristics before stepping on the level is necessary.

Toe landing was one of the important strategies during stepping down, being utilized by leading leg generated more negative work to reduce stair descending momentum. Higher velocities and less frequencies of toe landing were occurred (van Dieën & Pijnappels, 2009). The foot-ramp angle and foot kinematics before stepping would be crucial variables for evaluating transition.

To do exercise actively for improving physical abilities of elderly adults is the most important in order to decrease the likehood of fall in stepping down. Among all exercises, Tai-Chi has been promoted and widely accepted that the motion characteristics are quite suitable for older people. Nowadays, many studies about the effects of Tai-Chi on human body focused on physiological test, gait and balance control, we assumed that Tai-Chi would enhance the abilities of functional movement in diary life in elderly. The purpose of this study was to investigate the difference between TC exerciser and normal elderly in stepping characteristics before stair walking transition.

METHODS: Twelve TaiChi(TC)-practitioner (TC group) elderly (night male and three female) and fourteen matched control elderly (CON group) (eight male and six female) participated in this study with informed consent. The ages, weight and height of TC and control group were

74±6 / 66±1 years, 58±6 / 59±11 kg and 1.62±0.08 / 1.60±0.08 m, respectively. TC group had practiced TC for an average of 10 years, with a range from 2 to 15 years. TC practitioners practice ranged from six to seven days every week, at least one hour each time.

The staircase used in this study consisted of three steps, each step with a rise 18 cm and a run of 28 cm. A ten camera motion analysis system (Vicon MX 13+, Oxford Metrics, UK) sampling at 250Hz captured 49 retro-reflective makers based on plug-in gait placements, to computer center of mass (CoM) velocity, foot-ramp angle and ankle angular velocity. “Before transition” was defined as the moment before contacting the ground one video frame (1/250 sec).Stride length was the distance between right and left TOE markers while contacting the ground.

Each practitioner performed stair descent and then forward walking after contacting ground in self-selected speed, and at least five successful trials with barefoot. From digitized maker trajectories by Vicon Nexus (Vicon, Oxford Metrics, UK), Visual3D software (C-motion, Germantown, USA) filtered trajectories by low-pass 6 Hz and built whole body segments, and the CoM trajectories were obtained. According to the event of “contacting ground”, descending and following walk CoM velocity were calculated by before and after one second, respectively The significance was evaluated by independent samples t-test on the CoM velocity and characteristics of ground reaction forces.

RESULTS: The data of CoM velocity during before and after contacting the ground, the TOE marker velocity, foot-ramp angle and ankle angular velocity are shown in Table 1. During descending and following walk, TC group performed faster CoM velocity. At the moment of just before transition, TC group showed faster resultant / horizontal CoM velocity, TOE resultant / vertical velocity. TC group also demonstrated greater stride length while contacting the ground.

Table 1

CoM velocity and foot kinematics of Taichi and Normal groups.

	TC group (n=12)	CON group (n=14)
Descending CoM velocity (m/s) *	0.68 ± 0.08	0.62 ± 0.07
Following walk CoM velocity (m/s) *	0.94 ± 0.11	0.79 ± 0.09
CoM velocity before transition		
Resultant velocity (m/s) *	1.07 ± 0.12	0.90 ± 0.12
Horizontal component (m/s) *	0.91 ± 0.12	0.69 ± 0.12
Vertical component (m/s)	-0.53 ± 0.06	-0.55 ± 0.08
TOE velocity before transition		
Resultant velocity (m/s) *	0.73 ± 0.11	0.61 ± 0.10
Vertical component (m/s) *	-0.65 ± 0.08	-0.55 ± 0.10
Foot-ramp (°)	-19.95 ± 2.78	-19.06 ± 5.35
Ankle angular velocity (m/s)	246.6 ± 45.7	237.4 ± 41.9
Stride length (m) *	0.50 ± 0.06	0.36 ± 0.05

*p<.05

DISCUSSION: The speeds of both descending and following walk in this study were not restricted in order to simulate diary-life activities. Previous studies represented that young adults descending with faster velocities compared with older adults, because cautious negotiations in elderly were used to reduce the risks of falling (Hamel & Cavanagh, 2004; Mian, Narici, Minetti, & Baltzopoulos, 2007; Zietz, Johannsen, & Hollands, 2011). The faster descending speeds in TC group were speculated that TC group would have better abilities of body control.

Sheehan and Gottschall (2011) indicated stair walking transitions were a unique anticipation of the upcoming surface. To understand the affects of TC pratice in negotiated anticipation during transitions, the components of CoM velocity would be necessary to analyze. Because of no differences in vertical CoM velocity, the faster CoM velocity in TC group caused by faster horizontal CoM velocity before transition. The negotiations in TC group of faster horizontal CoM velocity would be in order to transfer descending to forward following walk more efficient. This was evident in faster following walk CoM velocity. On the other hand, the faster horizontal CoM velocity was accompanied greater stride length to decelerate the forward momentum.

Toe landing was one of the important strategies during stepping down. Although van Dieën and Pijnappels (2009) found that higher velocities and less frequencies of toe landing were occurred, neither foot-ramp angle nor ankle angular velocity had significant differences between two groups before transition. The greater vertical TOE velocity led faster TOE velocity in TC group. Considering the greater horizontal CoM velocity before transition, the faster TOE velocity might be the compensatory strategy to transit the unstable situation more efficient in TC group.

CONCLUSION:

The abilities of body control in TC group were better, reflected as faster descending and following walk velocity. Faster horizontal CoM velocity and vertical TOE velocity negotiated before transiton in TC group, would be order to transit the unstable situation more efficient.

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